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## USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS

## GEOPHYSICS, ASTRONOMY AND SPACE

No. 427

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## I. ASTRONOMY

### Abstracts of Scientific Articles

#### SOLAR ACTIVITY, COSMIC RAY VARIATIONS AND NEUTRINOS

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA FIZICHESKAYA in Russian Vol 42, No 5, 1978 pp 939-977

[Article by G. Ye. Kocharov, S. S. Vasil'yev, V. A. Dergachev, I. A. Ibragimov, G. A. Koval'tsov, L. G. Kocharov, N. I. Mal'chenko, R. Ya. Metskhvarishvili and S. Kh. Tleugaliyev, Physical-Technical Institute USSR Academy of Sciences, "Solar Activity, Cosmic Ray Variations and Neutrino Fluxes"]

[Abstract] On the basis of exploitation of 71 sources in the literature an attempt has been made to examine a broad range of phenomena in the solar system for the purpose of ascertaining the relationships among them. The study indicated that the plasma effects in the deep layers and in the atmosphere of the sun can be responsible for low fluxes of high-energy neutrinos and anomalously high fluxes of  $^3\text{He}$  nuclei and heavy elements. It was demonstrated that the detection of different groups of neutrinos can considerably broaden our knowledge concerning the properties of dense and hot plasma. It was found that plasma effects in the deep layers of the sun can exert an influence on the distribution of different isotopes in the internal parts of the sun and this can be reflected in the isotopic composition of the solar wind and solar cosmic rays. It was established that a detailed study of the isotopic composition of solar corpuscular streams can ensure not only a determination of the physical properties of the solar atmosphere, but also the dynamic characteristics of high-energy processes on the sun in the past. Also examined are the results obtained in studies of solar activity and the prospects for study of cyclic and flare activity on the sun by measurements of  $^{14}\text{C}$  in tree rings,  $^{26}\text{Al}$  and  $^{10}\text{Be}$  in bottom deposits. The authors also review the importance of complex investigations of the propagation of cosmogenic isotopes in different objects in the solar system.

[Note: This paper was from Materials of the All-Union Conference on Cosmic Rays (Yakutsk, June 1977)]

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## ELEVEN-YEAR COSMIC RAY VARIATIONS IN 19TH AND 20TH CYCLES

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA FIZICHESKAYA in Russian Vol 42, No 5, 1978 pp 1022-1025

[Article by A. I. Kuz'min, N. P. Chirkov, V. A. Fillipov and G. V. Shafer, Scientific Research Institute of Nuclear Physics Moscow State University, "Eleven-Year Cosmic Ray Variations in the Nineteenth and Twentieth Solar Activity Cycles"]

[Abstract] Despite the great number of studies made of the 11-year variations in cosmic rays, their nature remains largely unexplained. This paper gives the results of long-term observations of cosmic ray variations carried out at Yakutsk and Tiksi Bay. It is shown that the 19th and 20th solar activity cycles are manifested differently in 11-year cosmic ray variations. This difference is particularly significant in the energy spectra. The equations which have been derived show that in addition to solar activity, an appreciable role is also played by the influence of geomagnetic activity, that is, the velocity of the solar wind. Whereas the correlation coefficient between solar and geomagnetic activities and between the intensity of cosmic rays in the 19th solar activity cycle is quite high, in the 20th cycle there was virtually no correlation between geomagnetic and solar activity and the correlation between the intensity of cosmic rays and geomagnetic activity decreased sharply to 0.3 and became the reverse. The results show that the 11-year variations in cosmic rays in even and odd cycles are different; the greatest difference is in their energy spectra. The odd cycles are characterized by a harder energy spectrum than in the even cycles. It is also clear that the solar wind plays a major role in the 11-year cosmic ray variations. [Note: This paper is from the Materials of the All-Union Conference on Cosmic Rays (Yakutsk, June 1977)]  
[487]

## SPECTRA OF SOME VARIABLE RADIO SOURCES OBSERVED WITH RATAN-600 TELESCOPE

Yerevan ASTROFIZIKA in Russian Vol 14, No 1, 1978 pp 91-98

[Article by M. G. Mingaliyev, S. A. Pustil'nik, S. A. Trushkin, R. M. Kirakosyan and V. G. Malumyan, Special Astrophysical Observatory, Institute of Radiophysics and Electronics Armenian Academy of Sciences and Byurakan Astrophysical Observatory, "Spectra of Some Variable Radio Sources According to Observations Using the RATAN-600"]

[Abstract] On the basis of the results of observations with the RATAN-600 radio telescope at wavelengths 2.08, 3.9, 6.52 and 13.0 cm it was possible to obtain the spectra of some variable radio sources for the epochs 1976.25 and 1976.75. The observations were made using the northern sector of the

RATAN-600 using standard radiometers in two cycles: 20 March-10 April and 11-31 September 1976. In the observations use was made of a regime of transit of the source through a fixed directional diagram. The half-width of the directional diagram in the horizontal plane at a wavelength  $\lambda$  2.08 cm, for example, varied from  $\approx 12''$  at the zenith to  $\approx 16''$  at the horizon. Full details are given concerning calibration and measurement errors. A total of 18 sources were observed; a new source, Markaryan 509, was discovered. One of the purposes of this study was testing of some of the possibilities of estimating the angular dimensions of compact radio components on the basis of the structure of the instantaneous radio spectrum. This possibility is illustrated using the recorded spectra. The article discusses the possibility of using these spectra in selecting the optimum lengths of bases when making observations with interferometers having superlong bases. [486]

#### CORRECTING OBSERVED PROFILE OF SPECTRAL LINES FOR INSTRUMENTAL INFLUENCE

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 55, No 3, 1978 pp 649-659

[Article by I. Sattarov, Astronomical Institute Uzbek Academy of Sciences, "Numerical Methods for Correcting the Observed Profile of Spectral Lines for Instrumental Influence"]

[Abstract] The author examines the following numerical methods for correcting the observed profile of spectral lines for the influence of the instrumental profile: Burger-van Cittert and the Fourier transform with the use of regularization. It is demonstrated that in the case of spectral lines with a half-width two or more times exceeding the half-width of the instrumental profile both methods give close results. However, in the case of lines with a narrow profile the Fourier transform with regularization gives a better solution than the Burger-van Cittert method.

[480]

#### HARD GAMMA RADIATION FROM CENTRAL REGION OF GALAXY

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA FIZICHESKAYA in Russian Vol 42, No 5, 1978 pp 907-911

[Article by A. I. Belyayevskiy, V. L. Bokov, V. K. Bocharkin, I. F. Bugakov, G. M. Gorodinskiy, Ye. M. Kruglov, Ye. V. Myakinin, G. A. Pyatigorskiy, Ye. I. Chuykin, V. S. Yuferev, Yu. A. Shibano, E. N. Kolesnikova and B. A. Beloborodko, Physical-Technical Institute USSR Academy of Sciences, "Hard Gamma Radiation from the Central Region of the Galaxy and the Diffuse Background According to Data from the 'Kosmos-561' Artificial Earth Satellite"]

A gamma telescope with acoustic spark chambers was twice used in a space experiment aboard the artificial earth satellite "Kosmos-561" in 1973. The purpose of the experiment was the detection of local sources of gamma radiation with a flux  $F_\gamma (>100 \text{ MeV}) \gg 10^{-5} \text{ quanta} \cdot \text{cm}^{-2} \cdot \text{sec}^{-1}$  and measurement of the diffuse background of gamma rays with high energies. The results of the first flight are discussed. Figure 1 is a diagram of the gamma telescope. The structure and functioning of the instrument are discussed. It was possible to determine the flux of  $\gamma$ -quanta with  $E_\gamma \geq 100 \text{ MeV}$  from the band along the galactic equator with the coordinates  $b^{\text{II}} = \pm 10^\circ$ ,  $l^{\text{II}} = -35 - +25^\circ$ , equal to  $(1.77 \pm 0.74) \cdot 10^{-4} \text{ cm}^{-2} \cdot \text{sec}^{-1} \cdot \text{rad}^{-1}$ . For the first time it was possible to obtain the spectrum of  $\gamma$ -radiation from the central region of the Galaxy in the energy range 100-700 MeV. The exponent of the integral power law spectrum was equal to  $1.52 \pm 0.49$ . The authors have estimated the upper limit of the diffuse background:  $(7.1 \pm 3.5) \cdot 10^{-5} \text{ quanta} \cdot \text{cm}^{-2} \cdot \text{sec}^{-1} \cdot \text{sr}^{-1}$ . [This paper is from the Materials of the All-Union Conference on Cosmic Rays (Yakutsk, June 1977)]

[487]

#### SILYa-4 SPECTROMETER FOR ISOTOPES OF LIGHT NUCLEI

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA FIZICHESKAYA in Russian Vol 42, No 5, 1978 pp 1034-1037

[Article by A. V. Khrimyan, N. A. Nalbandyan, A. A. Avakyan, G. V. Khrimyan, T. G. Vartanyan and M. Zh. Mkrtchyan, Institute of Physical Research, Academy of Sciences Armenian SSR, "Spectrometer for Isotopes of Light Nuclei, the SILYa-4, for Investigating Cosmic Rays Outside the Earth's Atmosphere"]

[Abstract] The article describes the SILYa-4 mass spectrometer developed especially (1964-1974) for operation aboard artificial earth satellites. The SILYa-4 operated aboard the "Kosmos-557" satellite and on the "Salyut-4" orbital station. The physical characteristics of the spectrometer were as follows: a) the masses of hydrogen and helium isotopes are measured with a mean square error  $\leq 20\%$ ; b) against the background of the proton flux  $N_p$  the threshold for detection of deuterons is  $I_d \leq 5 \cdot 10^{-3} N_p$ ; c) the identification of H, He, Li, Be nuclei is accomplished by measurement of the charge. The spectrometer mass is  $100 \pm 2 \text{ kg}$ ; it measures  $752 \times 670 \times 565 \text{ mm}$ ; the required power is  $20 \text{ W}$  ( $27 \text{ V}$ ); the number of control commands is 7; the number of telemetric parameters is 36 (of which 26 were scientific and 10 were functional); the number of photomultipliers is 18; the number of semiconductor components is 1,657. The SILYa-4 spectrometer consists of the following parts (shown in the functional diagram, Fig. 1): scintillation telescope, control unit, amplitude analyzers unit; converters -- stabilized current sources for the photomultipliers, scintillation counters and radioelectronics unit. The structure and functioning of the instrument are discussed. [Note: The paper is from Materials of the All-Union Conference on Cosmic Rays (Yakutsk, June 1977)].

[487]

## BALLOON INVESTIGATIONS OF HIGH-ENERGY PARTICLES IN MAGNETOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA FIZICHESKAYA in Russian Vol 42, No 5, 1978 pp 1059-1062

[Article by I. A. Zhulin, L. L. Lazutin and Zh. P. Treyu, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation and Polar Geophysical Institute, Kola Affiliate USSR Academy of Sciences, "Investigation of High-Energy Particles in the Magnetosphere Under the 'Sambo' Program of International Balloon Experiments"]

[Abstract] The "Sambo-1" Soviet-French complex balloon experiment was carried out in February-March 1974. Its principal objective was an investigation of the dynamics of high-energy electrons (20 keV) during magnetic disturbances. The balloons were launched in series (2-4) in a polygon near Kiruna and drifted eastward to the Urals with a distance about 100 km apart. The balloons carried a complex of instruments, including sensors of cosmic rays, magnetospheric particles, auroras and electric fields. The principal detector was a scintillation spectrometer for registering X-radiation generated at the boundary of the atmosphere by high-energy electrons. This article discusses data relating to the behavior of the energy spectrum of X-radiation and information is given on the possible acceleration mechanisms. The clear manifestation of the nondependence in the behavior of the two energy components in auroral photons (and accordingly, auroral electrons) is a weighty argument supporting the hypothesis of existence of two mechanisms for the acceleration of particles with time separation in different stages of magnetospheric disturbances. Such mechanisms can be the acceleration by the large-scale convection field and a localized induced field. In actuality, with joint magnetic and  $E \times B$  drift the energy increment is proportional to the potential difference passed through by the particle. The second type of acceleration is related to an electric induced field arising during sharp restructurings of the magnetosphere at the beginning of the active phase of a substorm. The increment of particle energy can be quite great because the strength of the induced field cannot have significant limitations and is determined only by the rate of magnetic field change and the degree of its localization. The limited extent of the induced field, following from the localization of manifestations of the active phase of the substorm, is significantly reflected in the energy spectrum of the accelerated particles; the high-energy electrons are transported more rapidly from the acceleration region due to magnetic drift and the resultant spectrum of accelerated particles will be soft. [Note: The paper was taken from the Materials of the All-Union Conference on Cosmic Rays (Yakutsk, June 1977)]

[487]

## II. METEOROLOGY

### Abstracts of Scientific Articles

#### ROLE OF HORIZONTAL FRICTION IN TROPICAL CIRCULATION

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 14, No 5, 1978 pp 538-542

[Article by L. Kh. Ingel', Institute of Experimental Meteorology, "Role of Horizontal Friction in Tropical Circulation"]

[Abstract] At the present time too little is known about the physical mechanisms of horizontal friction (especially in the low latitudes) or their values and little work has been done on the methods for their parameterization. Most frequently the contribution of these forces is described in the equations of hydrodynamics by some effective coefficient of horizontal turbulent exchange  $K_H$  by analogy with the vertical turbulence coefficient. This leads to great uncertainty in the modeling of large-scale circulation. As shown in this article, one of the possible ways to overcome this uncertainty is the creation of models with different  $K_H$  values and subsequent comparison of the results with one another and with field data. In the case of a fixed pressure field, with an increase in viscosity the velocity components decrease in absolute value. There is a particularly rapid decrease in the advective terms, quadratic in velocity, which are particularly small in the case of small pressure gradients (as are observed in the equatorial zone). It is therefore a very likely hypothesis that in the case of sufficiently great  $K_H$  values movement in the equatorial zone will be purely "viscous": the force of the pressure gradient is counterbalanced by the force of horizontal friction. If Coriolis force is also taken into account, it can be expected that the solution of the equations of atmospheric dynamics with increasing distance from the equator will automatically pass into a geostrophic expression. Such a model is described in this paper. [The situation proved to be more complex than could be expected from the cited simple considerations.]

[434]

### III. OCEANOGRAPHY

#### News

#### "AKADEMIK KURCHATOV" PARTICIPATES IN "POLIMODE" EXPERIMENT

Moscow IZVESTIYA in Russian 28 Jul 78 p 3

[Article by V. Vukovich: "To the Secrets of the Ocean"]

[Abstract] The scientific research ship "Akademik Kurchatov" has sailed from Kaliningrad towards the Bermuda Triangle, where it will participate in the final stage of the joint Soviet-American hydrophysical "POLIMODE" experiment. [5]

[516]

#### NOTES ON OPERATIONS OF "AKADEMIK VERNADSKIY"

Moscow PRAVDA UKRAINY in Russian 14 Jul 78 p 3

[Article by V. Petrenko]

[Summary] The "Akademik Vernadskiy," research vessel and flagship of the research fleet of the Ukrainian Academy of Sciences, recently departed on a distant voyage from Sevastopol'. Boris Alekseyevich Nelepo, Academician Ukrainian Academy of Sciences, was aboard and prior to departure furnished the following information. With reference to the POLIMODE program, he stated that the work carried out during the summer and autumn of 1977 and the winter and spring of 1978 has made it necessary to re-examine many concepts concerning processes transpiring in the world ocean. Within the framework of the POLIMODE program Soviet and American researchers studied eddy formations present in the ocean. They arise from meanders -- numerous branches of the Gulf Stream. Some of these meanders become detached from the Gulf Stream and independently travel about in the ocean. The water masses in such structures rotate with a velocity up to 2 m per second and these eddy formations usually move in the ocean several kilometers per day. Scientists of both countries have thoroughly investigated eddy formations and studied

their specific movements, changes in water temperature, its density and other parameters. It was found that such structures, which have been given the name "Gulf Stream rings," differ from "eddies of the open ocean" in being of greater height and lesser diameter and also a more intensive circulation of water masses. The Gulf Stream, "rings" and "open ocean eddies" evidently constitute a unified dynamic system. It can be postulated that such systems exert a significant influence on the heat balance in the oceanic weather "kitchen." This means that study of the rings and open ocean eddies, and especially measurement of the quantity of heat transported by them, will favor the development of criteria and methods for long-range weather forecasting. Moreover, it has been established that in giant eddies there is an increase in the biological productivity of plankton and other organisms. While working in the Bermuda Triangle Soviet specialists observed no phenomena which could account for its ill fame. However, he noted that in March of this year the crew of the "Salyut-6"- "Soyuz" reported and photographed from space some rather interesting color anomalies in the ocean near the Bahamas. But specialists have not yet drawn any conclusions concerning these observations. But during the current voyage the "Akademik Vernadskiy" will make observations in this area and it is hoped that a definite answer will be found. This voyage will be the concluding stage of research under the POLIMODE program and will take place in approximately the same part of the Atlantic as the preceding voyages.

[495]

## Abstracts of Scientific Articles

### REFRACTIVE INDEX IN NEAR-WATER LAYER OF ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 14, No 5, 1978 pp 549-553

[Article by N. A. Dorfman, V. A. Kabanov, F. V. Kivva and I. S. Turgenev, Institute of Radiophysics and Electronics, Academy of Sciences Ukrainian SSR, "Statistical Characteristics of Refractive Index in the Near-Water Layer of the Atmosphere"]

[Abstract] For studying the spatial and temporal statistical characteristics of the refractive index in the near-water layer of the atmosphere over the Black Sea during 1973-1976 the authors carried out systematic measurements of the atmospheric refractive index  $n$  in a layer with a height up to 40 m. The measuring apparatus consisted of a SHF refractometer and a device making it possible to change smoothly the height of the measuring resonator of the refractometer in relation to sea level up to 40 m above the surface. Registry of the dependences  $n(h, t)$  ( $h$  and  $t$  are height and time) was carried out by means of self-recorders in the frequency band  $f \leq 1$  Hz. In the region of low frequencies the measured characteristics  $n(h, t)$  were limited by the duration of individual records, about 5-10 minutes. Usually in the course of the day there were 2 or 3 measurement sessions in the morning, daytime and evening hours. With a direction of the wind from the sea a study was made of 676 vertical profiles. The averaged curves were classified into four groups: with negative refraction, with low refraction, high refraction, superrefraction. It was found that in most cases during the course of the year in the investigated region in the lower layer up to 40 m above sea level there was increased refraction and superrefraction. The relative number of cases with superrefraction can be maximum in the summer months and attains 67% in July. The relative number of cases with negative refraction is maximum in the winter months. The processed data thus show that the temporal instability and spatial nonuniformity of the refractive index are particularly clearly expressed in the near-water layer, experiencing the thermal and dynamic effect of the sea surface.

[434]



## FUNCTIONAL SMOOTHING IN THE TURBULENCE PROBLEM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 240, No 5, 1978 pp 1058-1061

[Article by M. A. Gol'dshtik and V. N. Shtern, Heat Engineering Institute, Siberian Department USSR Academy of Sciences, "Method of Functional Smoothing in the Turbulence Problem"]

[Abstract] The principal difficulty in the analysis of turbulence is the extreme complexity of an individual record or its Fourier transform. Therefore, for smoothing recourse is to statistical averaging of a set of records, which generates an unclosed system of equations -- a Friedman-Keller chain. This gives rise to a closing problem, which still has not been correctly solved. The point of departure in solving the problem is the assumption that in phase space there is an attracting set in which almost all trajectories having an ergodic property enter with time. This makes it possible, in place of solution of the Cauchy problem, to seek at once a stationary solution. A set of such solutions forms a stable class. For their description it is customary to use Fourier-Stieltjes integrals. However, in this study the authors directly examine a limiting transition from a classical case and a method is proposed for discriminating the smooth part of the Fourier transform of the turbulent record. This leads to a closed system of equations for the function determining the moments of the pulsation fields and their spectral characteristics.  
[460]

## FINE THERMAL STRUCTURE OF OCEAN SURFACE LAYER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 240, No 5, 1978 pp 1066-1069

[Article by A. V. Solov'yev and N. V. Vershinskiy, Institute of Oceanology, "Fine Thermal Structure of the Surface Layer"]

[Abstract] This paper describes the experience in measuring the vertical distribution of temperature in the surface layer of the ocean by means of a floating-up probe in the region of the "Polimode-77" polygon, situated to the south of the Bermudas. The floating-up probe is fabricated from duralumin pipe and has positive buoyancy. The sensing element of the sensor is on the upper sealed lid. The sinking of the probe to the stipulated depth and the subsequent triggering (release) are accomplished by means of a ballast electromagnet which is connected to the rear cover of the probe. The floating-up probe is joined to the ship's side by an elastic coaxial cable. The rate of probe motion during free rising is 97 cm/sec. The measurements were made on the 25th voyage of the scientific research ship "Akademik Kurchatov" in August-October 1977. It was established that the thermal structure of the surface layer of the ocean is strongly dependent

on wind velocity. It was found that beneath the surface film of cold water on a millimeter scale there is a warm layer. It usually has a thickness from several centimeters during the daytime to several meters in the evening. Within this layer the temperature stratification closer to the surface is slightly unstable; then with an increase in depth it gradually becomes stable. At the lower boundary of the mixed layer there is a marked temperature decrease. The vertical temperature gradient here attains  $1^{\circ}\text{C}\cdot\text{m}^{-1}$ . At greater depths the temperature gradient slowly decreases. With an increase in wind velocity the surface layer becomes turbulent and the thickness of the mixed layer increases. The phenomenon in general resembles the upper quasihomogeneous layer and the seasonal thermocline, but differs from them by having a lesser spatial and temporal scale.  
[460]

#### TURBULENT BOUNDARY LAYER IN STRATIFIED FLUID

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 14, No 5, 1978 pp 562-565

[Article by M. Yu. Belevich and D. V. Chalikov, Institute of Oceanology, "Development of a Turbulent Boundary Layer in a Stratified Fluid"]

[Abstract] A study was made of a stably stratified fluid at rest with a density gradient  $\gamma$  which is constant with depth. At the time  $t = 0$  a shearing stress develops at the surface and then remains constant. A turbulent boundary layer with the thickness  $h(t)$  develops in the forming current due to velocity shear. An equation is derived which describes the increase in thickness of the mixed layer under the influence of friction applied to the surface. It can be used in computing the thickness of the quasihomogeneous layer in the ocean in a case when the thickness is considerably less than the depth of the Ekman layer when there is a small flow of mass through the surface. Then it was possible to derive an expression describing the temporal evolution of surface velocity. A final expression is then obtained which satisfactorily describes the evolution of surface velocity with a number of variables taken into account and with the constants having known values.

[434]

#### SPECTRAL INVESTIGATIONS OF FLUCTUATION OF UNDERWATER LIGHT FIELD

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 14, No 5, 1978 pp 565-569

[Article by V. G. Yakubenko, V. P. Nikolayev and M. S. Khulapov, Southern Division, Institute of Oceanology, "Effect of Drift of a Light Detector on the Results of Spectral Investigations of Fluctuations of the Underwater Light Field"]

[Abstract] The article presents the results of numerical modeling of fluctuations of the underwater light field (FULF) and the results of the first experimental checking of this effect. The authors modeled FULF at a depth of 10 m, registered using a narrow-angle ( $6^\circ$ ) light detector oriented at the center of a light spot and moving at a stipulated velocity. Figure 1, for different velocities of light detector motion, shows the temporal change (each 0.5 sec) in the profile of a sector of the sea surface situated over the light detector. Data are given on the dependence of the dispersion of FULF on velocity. Figure 2 shows the energy spectral density of brightness fluctuation of the ULF for different velocities of detector movement. The results of processing of FULF and wave records are also presented. The expressions derived indicate a possibility of determining the velocity and direction of movement of large-scale inhomogeneities of the sea surface on the basis of FULF records obtained using a moving light detector.

[434]

#### METHOD FOR DETERMINING LONGITUDINAL CONDUCTIVITY OF SEA SEDIMENTS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 319-323

[Article by I. L. Trofimov, V. S. Shneyer and S. M. Korotayev, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Determination of Total Longitudinal Conductivity of Sea Sediments and Total Flows from the Electromagnetic Field of Currents"]

[Abstract] In earlier studies the electric field induced during the flow of sea water in the earth's constant magnetic field has been used in determining the conductivity of the sea floor and total flows of currents. The purpose of this new investigation was a study of the possibility of solving these two problems without taking into account the spatial distribution of current velocity using the ratio of the mutually orthogonal horizontal components of the electric and magnetic fields of currents measured on the ocean floor at a single point. This ratio is the impedance  $Z$  of the ocean floor, determined from the current field. It is shown that using this impedance it is possible to ascertain the total longitudinal conductivity of the layer of sea sedimentary deposits and the total flow of water in the current.

[484]

#### EXAMINATION OF MARINE GRADIENT MAGNETIC SOUNDING METHOD

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 324-327

[Article by V. V. Sochel'nikov and R. N. Chzhu, Southern Division, Institute of Oceanology, "On the Method of Marine Gradient Magnetic Sounding"]

[Abstract] The lack of standard instrumentation for bottom magnetotelluric soundings is responsible for the present interest in gradient sounding methods. Gradient magnetic sounding is particularly important for increasing the accuracy in measuring the modulus of the total vector of magnetic field strength by proton and quantum magnetometers. The authors here give an analysis of the systematic errors in determining the geoelectric parameters of the cross section. It is shown that the most precise method is the method of scaling the results of measurements to the input impedance of the bottom. The method is inapplicable on the shelf where there are high values of the ratio of total longitudinal conductivity of the sedimentary and water layers. The use of data on the magnetic field near the shore line is inadmissible due to the strong influence of the shore effect.  
[484]

#### POSSIBILITIES OF USE OF MODULAR MAGNETOMETERS IN SEA SOUNDING

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, 1978 pp 377-378

[Article by G. A. Fonarev and L. B. Volkomirskaya, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Evaluations of the Possibilities of Using Modular Magnetometers in Some Apparatus for Sea Sounding"]

[Abstract] The theory of magnetotelluric soundings has been developed only for the components of the natural electromagnetic field. Therefore, in soundings it is customary to use component magnetic variation stations. When carrying out sea soundings the use of modular (quantum and proton) magnetometers as variometers would be of great interest because they have a number of valuable qualities -- high response, small errors due to oscillations, and absence of orientation errors (for proton magnetometers). In this paper an attempt has been made to evaluate the possibility of use of modular variometers in the following apparatus: gradient magnetic, surface and bottom Tikhonov-Cagniard apparatus. It is assumed that in these apparatuses the modular magnetometer is used as a variometer for the horizontal component of the magnetic field. An analysis revealed that in the greater part of the world ocean the use of modular variometers in the mentioned apparatus leads to great systematic errors. Nevertheless, in the low latitudes there is a region in which modular variometers can be used as variometers of the horizontal component of the magnetic field. In the low latitudes the systematic errors of modular variometers have little dependence on the type of source and are determined primarily by the I value. The use of modular variometers in gradient apparatus gives lesser systematic errors in comparison with the Tikhonov-Cagniard apparatus. The field of applicability of gradient apparatus with modular variometers is considerably greater than the field of applicability of Tikhonov-Cagniard apparatus.  
[484]

#### IV. TERRESTRIAL GEOPHYSICS

##### Abstracts of Scientific Articles

##### DETERMINING CONFIGURATION OF ANOMALOUS SOURCES IN GRAVITY-MAGNETIC FIELDS

Kiev DOPOVIDI AKADEMIYI NAUK UKRAYINS'KOYI RSR. SERIYA B. GEOLOGICHNI, KHMICHNI TA BIOLOGICHNI NAUKY in Ukrainian No 5, 1978 pp 387-390

[Article by Ye. G. Bulakh and I. M. Korchagin, Ukrainian Academy of Sciences, Institute of Geophysics, "On Mutual Selection of Anomalous Sources in the Gravitational and Magnetic Fields"]

[Abstract] An algorithm is suggested for mutual selection of the configuration of three-dimensional and two-dimensional anomalous sources in the gravitational and magnetic fields. A prismatic body which is polygonal in the vertical plane is accepted as a fundamental approximation cell. The procedure consists of a series of algorithms of the gradient type, used to optimize the approximation constructed. Algorithms have been proposed for complex quantitative interpretation of different geophysical fields many times, but have not found wide application because the mathematical statements require the incorporation of an entire series of a priori assumptions: this greatly reduces the class of geological problems which can be solved within these statements. In addition, requirements concerning the surfaces of sources of different fields and the validity of the Poisson relationship between magnetic and gravitational potentials are essential limitations.  
[414]

##### TEMPERATURE DISTRIBUTION IN EARTH'S CRUST IN ASIAN USSR

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 241, No 1, 1978 pp 60-63

[Article by U. I. Moiseyenko, A. A. Smyslov and T. Z. Chadovich, All-Union Scientific Research Geological Institute, "Temperature Distribution in the Earth's Crust in the Southern Asia Part of the USSR"]

[Abstract] For an analysis of the distribution of deep temperatures the authors have systematized information on thermal conductivity, the geothermal gradient, heat flow and generation of radiogenic heat in geological

formations in the southern Asian part of the USSR, where in Mesozoic-Cenozoic times there was an intensive manifestation of tectonic and tectonic-magmatic activation processes. On the basis of an analysis of all presently available experimental data it was possible to compute the thermal conductivity equation for granite, diorite, basalt and other rocks. These equations were used in evaluating deep temperatures. The results of these computations for a section with a depth of 30 km are shown on a full-page map giving the distribution of deep temperatures over the territory of the southern part of the Asian USSR. The map shows that the highest temperatures are characteristic for the Baykal rift zone, where on the assumption of a solid state of the earth's crust at depths of 30 km, the temperature in individual sectors attains 1500-2000°C. The pattern of deep temperatures indicates an exceptional lateral nonuniformity of the temperature field of the earth's crust in the Asian part of the USSR, the presence of regions with low, to 300°C, temperatures (Siberian platform, Northern Kazakhstan and others) and high temperatures, over 1000°C, which can indicate the possibility of appearance of magma hearths. The heterogeneity of the temperature field causes the appearance of sectors with high horizontal geothermal gradients whose values sometimes attain  $80^{\circ} \text{ km}^{-1}$ . The position of zones with high horizontal geothermal gradients corresponds to sectors of increased thermoelastic stresses in the crust. These data can be used in the future in seismological regionalization and the discrimination of seismically dangerous sectors.

[509]

#### GENERAL SOLUTIONS OF INVERSE PROBLEMS IN GRAVIMETRY AND MAGNETOMETRY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 4, 1978 pp 104-117

[Article by V. N. Strakhov, Institute of Physics of the Earth, "General Solutions of Inverse Problems in Gravimetry and Magnetometry"]

[Abstract] At present the mathematical models method is the working tool for extracting information from geophysical observations. In most cases use is made of extremely narrow model classes within whose framework there is a uniqueness in solution of inverse problems and when there is definite a priori information there is conditional stability. The employed mathematical models are usually parametric and solution of the inverse problem within the framework of such models is reduced to the optimum choice of parameters on the basis of experimental data and a priori information. However, this approach to the extraction of information from observational data is not the only one possible. In this article a different approach is used. One introduces into consideration an extremely broad model class to which the sought-for solution of the inverse problem (distribution of gravitating or magnetized masses) is known to belong. A so-called general solution of the problem is obtained for this class and then, using definite extremal (or variational) principles, particular solutions (one or even several) are selected from this

general solution, such as correspond most closely to the a priori concepts concerning structure of the medium. The author feels that this second approach corresponds better to the spirit of classical field theory and is more flexible. The proposed method is fully described.

[443]

#### STRESSED STATE OF THE CORE FROM DEEP BOREHOLES

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 4, 1978 pp 125-130

[Article by L. G. Grabchak and A. B. Makarov, Moscow Geological Prospecting Institute, "Stressed State of the Core in Deep Boreholes"]

[Abstract] In the process of core drilling the rock making up the core will pass from one stressed state to another and the core is deformed. If the stresses in the earth are great (as occurs at great depths), the core deformations can be considerable and under definite conditions a core even of monolithic rock can be destroyed. Such a phenomenon has been observed when drilling superdeep boreholes in bedrock. Two factors acting on the core are considered in this article: rock pressure and axial load. These factors are responsible for a complexly stressed state of the core. Calculations of the stressed-strained state of the core and the face sector of the rock mass were made using an electronic computer for the following borehole parameters: hole depth 10,000 m; hole diameter 76 mm; core diameter 58 mm; core length 100 mm; rock density 2.7 g/cm<sup>3</sup>; elasticity modulus  $5.5 \cdot 10^{10}$  Pa; rock monolithic and absolutely elastic; axial load  $P = 5 \cdot 10^4$  H applied to borehole face. A formula is derived for describing stresses in the core and in the face zone during the drilling process. Specific results are given. For example, it was found that the most unfavorable state arises at the base of the core where there is an unloading of the vertical stresses and a concentration of radial stresses. A formula is given which makes it possible to compute the limiting depth at which core destruction will not occur.

[443]

#### USE OF SPACE PHOTOS FOR STUDYING DEEP CRUSTAL STRUCTURES

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 6, 1978 pp 16-24

[Article by V. V. Kozlov, A. A. Romashov, L. F. Volchegurskiy and V. T. Vorob'yev, All-Union Combine "Aerogeologiya," Institute of Geophysics and Regional Geology and State Center "Priroda," "Use of Space Photographs for Studying Deep Structures in the Earth's Crust of Petroleum and Gas Regions. Article III. Lineaments of the Aral-Caspian Region. Possibilities of Their Classification and Relationship to Dislocations"]

[Abstract] The authors carried out a thorough interpretation of space materials obtained primarily by the second expedition of cosmonauts (P. I. Klimuk and V. I. Sevast'yanov) aboard the "Salyut-4" in 1975. Original photographs taken with a KATE-140 camera (negative scale 1:2,400,000) and a multizonal FMS-80 photosystem (negative scale about 1:4,200,000) were used in compiling a space photomap at a scale of 1:2,500,000 in the projection adopted for general geological maps. This map was used as a basis for compiling the "Space Phototectonic Map of the Aral-Caspian Region." In the course of the work on compiling this map additional data were obtained on dislocations in this extensive region, within whose limits a number of petroleum and gas basins are situated. Particular attention was given to classifying the numerous lineaments which are visible on the photoimages. Figure 1 is a map of the defined lineaments; these are discussed in the text. Also defined were "microlineaments" and "superlineaments" and these have also been mapped and interpreted.

[462]

#### TECTONICS AND DEVELOPMENT OF VILYUYSKAYA SYNECLISE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 6, 1978 pp 25-31

[Article by B. A. Sokolov and Ye. P. Larchenkov, Moscow State University, "Tectonic Nature and Direction of Development of the Vilyuyskaya Syncline"]

[Abstract] Clarification of the tectonic nature and history of development of the Vilyuyskaya syncline is of great importance for studying the conditions for formation of petroleum and gas concentrations and increasing the effectiveness of exploration and prospecting work for these minerals. The Vilyuyskaya syncline, consisting for the most part of Paleozoic and Mesozoic deposits with a thickness up to 10 km, is situated in the eastern part of the Siberian Platform between the Anabarskaya and Aldanskaya anteklises. A structural peculiarity of this syncline is a clearly expressed longitudinal zonality. In the axial part of the syncline there is a decrease in crustal thickness and increased heat flows. The Moho here is at a depth of 24-27 km and dips to 30-33 km in the Aldanskaya and Anabarskaya anteklises. Figure 1 is a diagram of the principal structural elements, whereas Fig. 2 shows stages in syncline formation. Each stage is discussed in detail. The peculiarities of syncline development exerted an influence on petroleum and gas formation and the accumulation of hydrocarbons in the Lena-Vilyuy basin. The generation processes were influenced by the increased geothermal regime in the axial part of the syncline, as well as an increase in the thermal effect during folding in the Verkhoyanskaya geosyncline. The zones of possible petroleum and gas accumulation are associated primarily with dislocations and inversion anticlines and to a lesser degree with reflected folds. All this must be taken into account when carrying out gas and petroleum exploration.

[462]



## EFFECT OF ASTHENOSPHERIC INHOMOGENEITY ON MANTLE CONVECTION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 240, No 5, 1978 pp 1070-1073

[Article by Corresponding Member USSR Academy of Sciences E. E. Fotiadi, A. V. Ladynin and S. A. Tychkov, Institute of Geology and Geophysics, Siberian Department USSR Academy of Sciences, "Effect of Asthenospheric Inhomogeneity on Convection in the Mantle and Lithospheric Isostasy"]

[Abstract] Comparison of data on the distribution of asthenospheric zones and the results of study of isostasy in the territory of the USSR leads to a conclusion which at first glance seems paradoxical: in those places where asthenospheric viscosity is low and the processes of isostatic regulation should have a greater velocity there are in fact the greatest deviations from equilibrium. This is true, in particular, of the transition region from the Asiatic continent to the Pacific Ocean, the Pamirs and Kopet-Dag, Caucasus and Carpathians, that is, regions of alpine mountain formation and also the Baykal rift zone. On the other hand, on the East European and Siberian Platforms, in Central Kazakhstan and in the Altay-Sayan region, where there is no clearly expressed asthenosphere, there are no significant impairments of isostasy. It therefore follows that present-day differences in the isostatic state are caused not so much by differences in the rate of isostatic regulation, as by the intensity of continuing tectonic processes and that the latter are so related to the properties of the asthenosphere that a decrease in its viscosity is accompanied by an intensification of these processes. In order to clarify the influence of a deficit of viscosity in the asthenosphere on the temporal characteristics of the process of isostatic regulation the authors carried out mathematical modeling of this process in a two-layer viscous fluid with different density and viscosity of the layers and with an initial perturbation. Among the findings was that the viscosity deficit of the continental asthenosphere is 1-2 orders of magnitude sufficient so that the characteristic time of isostatic regulation would correspond to its determined empirical values and the velocity of the horizontal compensation current makes it possible to assume that such an asthenosphere is no obstacle for even greater horizontal movements of lithospheric plates. The viscosity deficit of the asthenosphere directly determines the geometry of the convective cells.

[460]

## CHARACTERISTICS OF DEEP FAULTS IN THE URALS

Moscow SOVETSKAYA GEOLOGIYA in Russian No 4, 1978 pp 146-154

[Article by V. S. Druzhinin, Ural Territorial Geological Administration, "Characteristics of Deep Faults in the Urals According to Seismic Data"]

[Abstract] This article is devoted to a study of the wave pattern over zones of deep faults, taking into account data obtained along the Sverdlovskaya profile, and the results of a systematic presentation of seismic data along different sections within the limits of the Urals. As an example of the discrimination of deep faults the author discusses in detail the zone of the Salatimskiy fault complex. Figure 1 shows the characteristics of the Salatimskiy deep fault in the upper part of the section; Fig. 2 is a ray and travel-time curve graph for the zone of the Salatimskiy deep fault; Fig. 3 shows the position of the Salatimskiy and other deep faults in the cross section on the basis of seismic data; Fig. 4 is the structure of the earth's crust in the Predural'skiy downwarp; Fig. 5 shows the structure of the earth's crust in the Kamyshlovskaya zone of deep faults. Also discussed in detail are the Krasnoufimskiy fault zone, the Bardymskiy zone of deep faults, the Serovsko-Maukskiy zone of deep faults, the Uktusko-Kashinskaya fault zone, the Kamyshlovskaya zone of deep faults and the Tyumenskaya zone of deep faults. A two-page table gives discrimination criteria and characteristics of deep faults in this region.  
[481]

#### RECEPTION OF ATMOSPHERIC INFRASONIC WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 14, No 5, 1978 pp 474-483

[Article by A. I. Grachev, S. V. Zagoruyko, A. K. Matveyev and M. I. Mordukhovich, Institute of Physics of the Atmosphere, "Some Results of Reception of Atmospheric Infrasonic Waves"]

[Abstract] The natural sources of infrasound in the atmosphere are thunderstorms, active volcanoes, earthquakes, auroras, sea storms and synoptic processes and the artificial sources are different kinds of explosions and the launchings of spaceships and rockets. Investigation of the propagation of infrasound is one of the methods for the study of atmospheric physics. At present the Institute of Physics of the Atmosphere has one station (near Moscow) for the study of infrasound (the station consists of three observation points). This paper describes two methods for the detection of signals in the infrasound range and determination of their characteristics: 1) spectral-coherent analysis for those signals which as a rule were not visible on the records of automatic recorders due to great turbulent fluctuations of pressure, 2) the method for determining the arrival time differences at observation points, from which are computed the signal characteristics for those cases when there is a possibility for visual detection of coherent signals on all records. An algorithm for computing the wave parameters is presented. The described method makes it possible to detect infrasound signals and to compute the wave parameters. In order to establish a correlation between waves in the infrasonic range and synoptic phenomena it is necessary to have a second station for the reception of pressure oscillations for the purpose of determining the location of the source.  
[434]

## FORMULATION OF A MORE GENERAL THEORY OF GLOBAL TECTOGENESIS

Moscow GEOTEKTONIKA in Russian No 3, 1978 pp 3-25

[Article by V. Ye. Khain, Moscow State University, "From the Tectonics of Plates to a More General Theory of Global Tectogenesis"]

[Abstract] After a brief enumeration of the principal points in the concept of lithospheric plates, the article characterizes the development of this concept during the last 10-15 years. An attempt is made to show that with the creation of the tectonics of plates or the new global tectonics a new stage in development has begun in geotectonics and theoretical geology in general. The principal points in the tectonics of plates in general form have been confirmed by the totality of available geological and geophysical information. A step of great importance will be the direct checking of the concepts of major horizontal displacements of the lithosphere by the method of interference radioastronomy and using laser reflectors set up on the moon. The accumulation of new factual material has not simply brought a general confirmation of the principles of neomobilism, formulated between 1962-1963 and 1967-1968, but has also required their substantial supplementation and even definite changes (as discussed in the article). On the whole the concept has experienced appreciable broadening and has taken on greater flexibility. In the near future this evolution will undoubtedly be so great that there is basis for expecting that the plate tectonics variant of neomobilism will develop into a more general theory of global tectogenesis. The theory will also take into account pulsations of volume of the earth and the influence of changes in the rotational regime of the planet.

[485]

## EARTH'S RELIEF IN LIGHT OF NEW TECTONIC CONCEPTS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, GEOLOGIYA in Russian No 2, 1978 pp 29-42

[Article by N. I. Nikolayev, Dynamic Geology Department, Moscow State University, "Structural Characteristics of the Earth's Relief in the Light of New Tectonic Concepts"]

[Abstract] The development of a generalizing geomorphological concept covering the genesis and development of the earth's surface relief is the fundamental and most timely task of geomorphology. The author reviews the progress made along these lines during recent years. Emphasis is on the concepts advanced in the field of theoretical geomorphology by I. P. Gerasimov and Yu. A. Meshcheryakov. During the last two or three years an attempt has been made to tie in their ideas to new geotectonic concepts — the

hypothesis of global tectonics of lithospheric plates. The article gives an in-depth critical examination of the new proposals relating to the most important structural characteristics of the earth's relief. Much of the article deals with the new terminology which has been creeping into the literature, which therefore is confusing to Russian (and foreign!) scientists. The theoretical basis of Soviet geomorphology is a recognition of the formation of relief as a result of interaction of two groups of processes: exogenous and endogenous. This is fully discussed in a critical way, with reference to specific authors. However, the author feels very strongly that the theory of lithospheric plates has major scientific and methodological shortcomings. He contends that this theory cannot be the basis on which it is possible to formulate a modern theory of geomorphogenesis.

[445]

#### NOTES ON DEEP DRILLING ON THE KOLA PENINSULA

Moscow ZNANIYE-SILA in Russian No 6, 1978 pp 24-25

[Article by L. Zhukova: "What is There in the Depths of the Earth?"]

[Abstract] The author visited the village of Zapolyarnyy on the Kola Peninsula, near which a superdeep hole is being drilled to the upper mantle. The site was selected because the electric pulses of geophysical instruments sent down into the earth predicted that the Conrad discontinuity (the separation between the granite and basalt layers of the earth's crust) would be found only five kilometers from the surface. But specialists have already obtained cores from a depth of 5,000 m, 7,500 m and 7,628 m and the drill is still encountering granite. The geophysical instruments have already made a 3-km error. The control-measuring instruments giving readings on fluid pressure, mechanical velocity, density, temperature, etc. for the most part were developed in the Laboratory of Control-Measuring Instruments at the Kola Geological Expedition. For the first time drilling is being done with an open shaft, without casings, that is, the borehole walls for more than 2,000 m are not cemented; this is because the granite is so strong. The turbodrill at the Kola superdeep well has been yielding one surprise after another. It had been computed that in the Precambrian horizons the temperature with each 100 m depth can increase by one degree. Accordingly, it should attain only 150° at a depth of 15 km. But already at 7 km the earth's heat exceeded 120° and on the approaches to 8 km it had reached 150°. What will it be at greater depths? Another surprise. At a depth of 6 km there was water. And the Precambrian layers had been considered impermeable. This is free, not bound water. Then it was found that at great depths the velocity of seismic waves does not increase, but instead decreases. But the greatest surprise was the discovery of the remnants of microorganisms which date back two billion years, whereas earlier it was believed that life had originated only 1.6 billion years ago.

[478]

## V. UPPER ATMOSPHERE AND SPACE RESEARCH

### News

#### TASS ANNOUNCES LAUNCHING OF "MOLNIYA-1" COMMUNICATIONS SATELLITE

Moscow PRAVDA in Russian 16 Jul 78 p 3

[TASS Report: "'Molniya-1'"]

[Text] On 14 July 1978 a "Molniya-1" communications satellite was launched in the Soviet Union. The "Molniya-1" communications satellite is intended for operation in the system of long-range telephone and telegraph radio communication and also for transmission of USSR Central Television programs to points in the "Orbita" network situated in regions of the Far North, Siberia, the Far East and Central Asia.

The satellite was inserted into a high elliptical orbit with the following parameters:

- apogee, 40,660 kilometers;
- perigee, 650 kilometers;
- period of revolution, 12 hours 17 minutes;
- orbital inclination, 62.8 degrees.

In addition to the apparatus for transmission of television programs and for providing long-range multichannel radio communication, the satellite has on board a command and measurement complex and also systems for orientation, orbital correction and power supply for the satellite.

According to the data received, the apparatus installed on the satellite is functioning normally. Communication sessions using the "Molniya-1" satellite will be conducted in accordance with the planned program.

[499]

## FEOKTISTOV COMMENTARY ON DEVELOPMENT OF ORBITAL STATIONS

Moscow TRUD in Russian 5 Jul 78 p 4

[Article by V. Golovachev: "The Future of the 'Salyut'"]

[Text] For seven days the international crew has worked on board the orbital space complex "Salyut-6"- "Soyuz-29"- "Soyuz-30." The seven-day joint flight program is coming to a close, and soon P. Klimuk and M. Hermaszewski will return to earth carrying with them the many results of the research studies and experiments already conducted.

"We have turned on the electric heater," said Petr Klimuk during one of the communication sessions. "The smelting operation is proceeding as planned."

He was referring to the continuation of technological experiments in the "Splav-01" automatic electric heating installation that is on the orbital station. Into the heating chamber the cosmonauts placed small cylindrical ampules with a solid solution of cadmium telluride and mercury telluride. These very different materials are heated to a very high temperature, melted, and then, scientists expect, they will crystallize as they cool, forming a homogeneous semiconductor. This semiconductor could be used in supersensitive medical and electronic instruments. The experiment was prepared jointly by Soviet and Polish specialists (an ampule was sent from the Polish Academy of Sciences Institute of Physics). The smelting of cadmium, mercury and tellurium was conducted earlier on the station within the frame of the Soviet national program. It will be interesting to compare the analysis data of these alloys as obtained by Polish and Soviet specialists.

Commenting on these studies, Candidate of Technical Sciences, USSR Pilot - Cosmonaut V. N. Kubasov, who participated in two space flights, noted:

"Due to technological experiments on the station, we are nearing the time when unique industrial plants making use of the vast space vacuum and weightlessness will be constructed in near-earth space. Such plants must necessarily be created and perhaps even sooner than supposed by science fiction writers. However, it is first necessary to conduct intensive research and to determine just which materials can be obtained in space and just how they are to be produced. When these studies are completed, the question of constructing workshops and entire industrial plants in orbit will arise. Perhaps it will be possible even for me to work in such a plant..."

We discussed this with the designer of space systems, Doctor of Technical Sciences Professor K. P. Feoktistov.

"I think that the development of space technology will be closely linked with industrial activity in near-earth space," said the scientist. "This, apparently, will include not only workshops and plants in orbit, but high-

capacity power stations as well. In fact, it is tempting to use solar energy to manufacture electricity, without polluting the earth and spoiling its natural resources. According to my estimates, the cost of such energy could be equivalent to that of what is presently being produced in earth-based power stations. Of course, these will have to be enormous structures. Let's say, an orbital power station with a 10-million kilowatt capacity will have to have solar cells with an area of 50-70 square kilometers. The antenna to transmit the energy to earth will be 1-1.5 kilometers in diameter. And the receiver on earth would cover an area of several square kilometers. Hundreds of these power stations would be required to accomodate all of mankind. And to construct them, factories in orbit to build the structural components are needed... Orbital stations are the experimental test area and the building ground for future industrial endeavors..."

"In what direction are the Soviet orbital stations developing?"

"Our first 'Salyut'," emphasized K. P. Feoktistov, "was, generally speaking, a 'test of the pen.' Many technical aspects of the 'Soyuz' transport ships, some of the equipment and components of the 'Soyuz' energy supply and orientation systems were adopted. The station was inserted into orbit on 19 April 1971 and proved to be highly useful. The service life of subsequent 'Salyut' ships was increased, and the energy indicators and fuel reserves were improved. New scientific equipment and airlocks for waste and refuse disposal appeared on 'Salyut-4', and the station was made more comfortable. But already as soon as 'Salyut-4' was launched, it was obvious that a second docking unit was needed. It is a pity to stop work on a station because its fuel reserves have been depleted. The second docking unit makes it possible to refuel the station and markedly widens its capabilities."

"I imagine that in the future there will be space stations with several docking units. Modules will be docked to allow specialized research, for example, in geophysics, astrophysics and technology, to be conducted..."

"Throughout the time of construction and operation of a station, the scientific equipment, of course, becomes outmoded. New modules can be outfitted with more highly developed technology. I think that priority development in the near future will be in the modular construction of orbital stations."

"Does the docking of a second transport ship and the presence of a second crew on board 'Salyut-6' affect the operational service of the orbital station?"

"First of all, additional regenerators on the station were switched on (they absorb the carbon dioxide and moisture from the atmosphere and isolate the oxygen). This time the specialists overdid it a bit: the number of regenerators on the station not only doubled, but tripled. But that,

of course, is nothing so awful: a surplus of oxygen simply makes it easier to breathe. In addition, when two transport ships are docked to the station, the routine of physical exercises on the trainer is somewhat altered. A 'restricted pace zone' on the treadmill is introduced to prevent structural resonance vibrations. That is, the pace must be either slower or faster than the resonance frequency. This 'restricted zone' was initially determined through calculations and then amended thanks to data obtained in the 'Resonans' experiment conducted during the first expedition. Calculations differed from experimental data by 0.3 Hz -- a significant discrepancy..."

The conversation is coming to a close. Kovalenok and Ivanchenkov report during the communications session that they have completed the daily program of physical exercise. For the past week they have exercised more than Klimuk and Hermaszewski. That is understandable: the 'Fotony' have been in space for twenty days whereas the 'Kavkazy' will soon be returning and after only one week. But all four have devoted much time to biomedical experimentation.

First M. Hermaszewski and then P. Klimuk put on special "trousers" (the "Chibis" suit) in which a vacuum and lower pressure are created. The vacuum acts on the lower part of the body, forcing the blood to flow downward to the legs. This in some way simulates the effect of gravity such as the cosmonauts will experience when they return to earth. How does the human organism react to this load; how is the cardiac function altered? The condition of the cosmonauts is monitored not only by the well-known comprehensive "Polinom-2M" device, but also by the new "Kardiolider," an instrument manufactured by an x-ray and medical equipment plant in Warsaw. This 200-g electronic instrument measures cardiac function and monitors changes in and the frequency of palpitation in a wide range -- from 60 to 180 beats per minute. Studies using the "Kardiolider" will be conducted on the bicycle-type ergometer.

Another experiment, "Kislород" ("Oxygen") is a continuation and development of studies begun under the "Interkosmos" program by the first international crew, Yu. Romanenko, G. Grechko, A. Gubarev and V. Remek. The portable on-board "Oksimetr" device, which was manufactured in Czechoslovakia, makes it possible to study the oxygen content of tissues of man in space. Klimuk and Hermaszewski brought new power packs for this device and installed them.

Using the MKF-6M multispectral space camera, the international crew photographed extensive territories of the Soviet Union and the world oceans for research in natural resources and environmental protection.

...In the few short minutes of leisure the cosmonauts float to the windows and admire our planet.



The joint expedition on "Salyut-6" is nearing its end. Yesterday P. Klimuk and M. Hermaszewski began transferring the results of scientific research in orbit -- film, flight journals, notes, etc. into the descent module of the "Soyuz-30." Soon they will head for home. [5]  
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#### COMMENTS ON "PROGRESS-2" CARGO

Moscow TRUD in Russian 11 Jul 78 p 3

[Article by V. Golovachev: "The Space Bridge is in Operation!"]

[Editorial Report] The "Progress-2" freight transport ship delivered 300 different types of supplies to the "Salyut-6" space station. According to Viktor Blagov at the Flight Control Center near Moscow, the cargo included 235 kilograms of food and 187 liters of water, that is, a 50-day supply for two cosmonauts or a 25-day supply for a crew of four. Also on board were four 80-kilogram regenerators and 124 kilograms of film. Its fuel tanks were not filled to capacity, carrying only 613 kilograms. [5]

#### CHRONOLOGY OF "SALYUT-6" MISSION 6 JULY -- 21 JULY 1978

[Editorial Report] Moscow PRAVDA in Russian, dated 8 Jul 78 through 22 Jul 78, TASS provides the following information on activities on board the manned "Salyut-6" space complex:

##### 6 JULY

6 July was devoted to medical experimentation, including studies of the cardiovascular system, the dynamics of blood circulation at rest and the bioelectric activity of man's heart in space. (PRAVDA 8 Jul 78 p 1)

##### 7 JULY

Cosmonauts Kovalenok and Ivanchenkov conducted tests of various on-board systems, exercised and worked with technical flight documentation. They completed an experiment in the "Splav-01" furnace to crystallize several types of high-quality optical glass. (PRAVDA 8 Jul 78 p 1)

#### "PROGRESS-2" LAUNCHED

On 7 July 1978 at 1426 hours Moscow time the "Progress-2" automatic freight transport ship was launched from the Soviet Union. It was inserted into an initial orbit with the following parameters:

- apogee, 262 kilometers;
- perigee, 193 kilometers;
- period of revolution, 88.7 minutes;
- orbital inclination, 51.6 degrees.

"Progress-2" was expected to dock with the "Salyut-6" -- "Soyuz-29" space complex, delivering fuel, scientific equipment, components for life support systems, and so on. (PRAVDA 8 Jul 78 p 1)

#### 8 JULY

#### 9 JULY

#### "PROGRESS-2" DOCKED

At 1559 hours Moscow time "Progress-2" docked with the "Salyut-6" station at the assembly bay docking unit. The approach and docking procedures were conducted automatically while cosmonauts Kovalenok and Ivanchenkov closely observed and monitored the operation.

The supply transport mission of "Progress"-type vehicles is expected to increase the service life and functional use of the "Salyut" station in the interests of science and the national economy. (PRAVDA 10 Jul 78 p 1)

#### 10 JULY

After checking the hermetic seal of the "Progress-2"--"Salyut-6" docking unit, cosmonauts Kovalenok and Ivanchenkov opened the hatch and entered the transport ship to examine its cargo. During the second half of the day, they began unloading operations. At the same time, specialists at the Flight Control Center began preparations for automatically refueling the "Salyut-6" station.

Other activities for the day included visual observations of the earth's surface, physical exercise and a television broadcast. (PRAVDA 11 Jul 78 p 1)

#### 11 JULY

#### 12 JULY

Cosmonauts Kovalenok and Ivanchenkov continued operations to unload food products, photographic materials and items for personal hygiene. They also dismantled one of the regenerators of the life support system and replaced it with a newly delivered one.

Simultaneously, preparations of the fuel tanks of the station's propulsion system continued as gas of the repressurization system was being evacuated from them. (PRAVDA 13 Jul 78 p 1)

### 13 JULY

By this date the crew had transported the greater part of the "Progress-2" cargo into the "Salyut-6" station. (PRAVDA 15 JULY 78 p 1)

### 14 JULY

Cosmonauts Kovalenok and Ivanchenkov used the "Polinom-2M," "Reograf," and "Beta" devices to monitor the condition of their cardiovascular systems under varying stress loads as they exercised on the bicycle ergometer.

The parameters of the microclimate within the space station were as follows:

- temperature, 20 degrees Celsius;
- pressure, 780 mm Hg. (PRAVDA 15 Jul 78 p 1)

### 15 JULY

### 16 JULY

The "Salyut-6"---"Soyuz-29" crew worked to install the new "Kristall" materials processing furnace, which was delivered to the station by the "Progress-2" freight ship. (PRAVDA 18 Jul 78 p 1)

### 17 JULY

17 July marked the end of the first month on board the "Salyut-6" space station for cosmonauts Kovalenok and Ivanchenkov.

The crew completed the first technological experiment in the new "Kristall" furnace, which is installed in the transfer compartment ("Splav" is in the airlock). The purpose of the experiment was to obtain a semiconductor monocrystal. All operations to maintain the optimum regimen within the electric heating chamber were conducted automatically.

Also during the day cosmonauts Kovalenok and Ivanchenkov made repairs, reloaded their cameras and conducted yet another materials processing experiment in "Splav."

According to medical data, the pulse of commander Kovalenok was 65/minute, of flight engineer Ivanchenkov -- 60/minute; their blood pressures were 120/65 and 130/60 respectively. (PRAVDA 18 Jul 78 p 1)

### 18 JULY

### 19 JULY

After the "Salyut-6"---"Soyuz-29" crew had tested the hermetic seals of the fuel lines and tanks, the command was given to begin the first stage of the automatic refueling operations. Cosmonauts Kovalenok and Ivanchenkov as

well as specialists at the Flight Control Center monitored the process.

The crew also conducted the next in a series of materials processing experiments in the "Splav" furnace. The experiment was to last two days. (PRAVDA 20 Jul 78 p 1)

#### 20 JULY

Today the second fuel component -- the oxidizer -- was pumped into the station's tanks, thus completing the entire refueling of the "Salyut-6" consolidated propulsion system ("ODU"). (PRAVDA 21 Jul 78 p 1)

#### 21 JULY

After reorienting the space complex, cosmonauts Kovalenok and Ivanchenkov photographed the earth's surface, in particular, Belorussia, the Ukraine, the Lower Volga, Kazakhstan, Central Asia and regions of the world's oceans.

During the second half of the working day, the crew conducted another "Splav" experiment. (PRAVDA 22 Jul 78 p 1)

All of the TASS statements indicated that the cosmonauts were well and that all systems were functioning normally. TASS information on flight activities for 8, 11, 15 and 18 July was not published in the Soviet press. [5]

#### SEMICONDUCTORS PROCESSED IN "KRISTALL" CHAMBER

Moscow PRAVDA in Russian 23 Jul 78 p 6

[Article by Yu. Apenchenko: "'Kristall'..."]

[Excerpt] "What is it that we find attractive in space?" continues A. Yu. Malinin. "It is primarily that under weightlessness conditions we can plan on obtaining materials which are perfect in structure and more uniform in composition than those which for the time being can be obtained from factories on earth. We hope that space technology will help us."

"For the first time in world practice a program for the 'Salyut-6' provided for obtaining not only large crystals, but also another class of materials coming into still broader practical use -- film structures. For this purpose a layer of another substance (or the same substance but with modified properties) is built up on the semiconductor surface; it has a thickness from tens of A to tens of microns and a geometry which is rigorously stipulated in advance. In space, where thermal processes, especially heat transfer, occur differently than on the earth, it becomes possible to create more perfect surfaces and transitional layers."

"Can you say anything about the practical yield from the experiments which have been initiated?"

"Yes, I can. For the time being we are planning on obtaining tens of grams of materials which we need. This to be sure, is not a lot, but it is already adequate for fabricating the first instruments and devices and to proceed to their testing..."

"How is all this being done there in orbit?"

"We have already reported that a new universal electric stove, the 'Kristall,' was delivered to the 'Salyut-6' from the transport ship 'Progress-2.' It consists of the thermal unit proper and a special computer which ensures operation of this unit in accordance with a stipulated program. The total weight of the 'Kristall' together with the packing material is about 28 kg; the construction is compact."

"I would like to mention one peculiarity of our apparatus," states the experiment director V. T. Khryapov. "Prior to this in space use was made of only one method for obtaining materials for electronics -- the growing of crystals by the method of directed crystallization. We made provision for using three other methods. In particular, we intend to obtain film structures both by the method of a gas transport reaction and by the moving solvent method."

"The thermal device ensures a stipulated form of the heat field: in accordance with the program the temperature at its different points can be varied from 0 to 1,100 degrees. Provision is also made for a stationary heating regime, holding of the melt and its cooling, as well as moving the melt along in the heat field. It goes without saying that safety is guaranteed: if the temperature at the 'Kristall' surface exceeds 50° the process is automatically stopped."

"The cosmonauts installed the apparatus in the transfer compartment and carried out the necessary preliminary tests. The first experiment with the cultivation of semiconductor material in the 'Kristall' was successfully completed. Vladimir Kovalenok and Aleksandr Ivanchenkov are continuing to work."

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#### TASS ANNOUNCES LAUNCHING OF "KOSMOS-1027"

Moscow PRAVDA in Russian 28 Jul 78 p 3

[TASS Report: "'Kosmos-1027'"]

[Abstract] The artificial earth satellite "Kosmos-1027" was launched in the Soviet Union on 27 July 1978. The satellite was inserted into an orbit with the following parameters:

- initial period, 104.8 minutes;
  - apogee, 1015 kilometers;
  - perigee, 979 kilometers;
  - orbital inclination, 82.9 degrees.
- [515]

#### PETROVSKIY DISCUSSES POTENTIAL FOR GLASS PROCESSING IN SPACE

Moscow IZVESTIYA in Russian 16 Jul 78 p 4

[Article by B. Konovalov: "Glassmakers in Space"]

[Text] The list of related professions which the cosmonaut must master is vigorously expanding before our eyes. Aboard the "Salyut-6" V. Kovalenok and A. Ivanchenkov for 27 hours were to become the first glassmakers in space. In the capsule of the "Splav" technological furnace they placed three ampules with samples of the principal types of glass mass used in world practice -- silicate, borate and phosphate. Over a period of 2 1/2 hours the cosmonauts held these samples at a temperature of 930 degrees and then cooled them sharply in order to fix the forming structure and then they carried out fine annealing of the glass in order to impart the necessary strength to it.

At the Flight Control Center one of the formulators of the experiment, Corresponding Member USSR Academy of Sciences G. Petrovskiy, told newspapermen about what horizons are opening up before science and technology from this first test in orbit.

"In his time Sergey Ivanovich Vavilov noted that glass is the main component of optical systems," says G. Petrovskiy. "This assertion is also correct in our day, despite the broad penetration of electronics into optical instruments. The mastery of space is opening new horizons before optics and is affording a possibility for using new technological procedures for the creation of valuable materials and improving the properties of glass. Optics was one of the scientific and technical directions which made the storming of space possible. From the first flight, when Yuriy Gagarin saw the earth through his window, it [glass] has been soundly serving cosmonauts. And now cosmonauts in turn can assist in the development of optical instrument making."

Glass is regarded as one of the most homogeneous materials, but if it is inspected under an electron microscope with a magnification of 20,000 it can be seen clearly that it has a complex structure. A number of extremely important physicochemical properties of glass are dependent on the nature of the microstructure and the distribution of inhomogeneities. Aboard a spaceship the role played by gravity is sharply reduced from what it is on

earth and there is an exceedingly great intensification of the importance of surface tension.

By means of certain additives it is possible to impart to the glass valuable properties which are widely used in modern technology. For example, the addition of niodymium ions makes it possible to obtain glass capable of generating laser radiation. "Admixtures" of terbium and cerium create magnetically active materials used as optical shutters which can transmit radiation in only one direction. Photochromic glass enjoys a great popularity; it becomes darker in the sun and becomes clearer in darkened rooms.

The more uniform the distribution of the additive, the better is the quality of such alloyed glass. But a uniform distribution is difficult to achieve under terrestrial conditions. On photographs taken using electron telescopes it can be seen that the ions of heavy "impurities" have a tendency to collect into groups, resembling swarms of bees. Scientists hope that under weightlessness conditions this interaction among ions of impurities will be weakened and the distribution of additives will be more uniform. In one of the ampules in which the melting and cooling of glass took place under weightlessness conditions specialists placed "additives" of iron in order to check this hypothesis.

Modern technology requires purer and purer glass. But no matter how much the purity of the initial materials is increased, there is a problem with the walls of the vessels in which the glass mass is melted. At a temperature of 1,400° there are very few materials which can retain their strength and the glass is inevitably contaminated. Even costly platinum vessels are no solution to the problem. Platinum also partially passes into the hot melt and with subsequent cooling is released, segregated, in the form of tiny crystals which considerably reduce the optical properties of the materials.

Space can also be of assistance here. Under weightlessness conditions it is possible to carry out crucibleless melting of glass, holding it by means of a system of acoustic sources creating a definite pressure. In principle, on earth if one makes use of very powerful acoustic generators it is also possible to "suspend" tiny masses, but after all, for industrial purposes it is necessary to have quite large particles. By such a method it is possible to obtain very pure glass or new types of glass with different additives which it is difficult to obtain under terrestrial conditions because very high temperatures are required and there are no vessels capable of withstanding them.

By means of the acoustic effect it is possible not only to suspend glass, but also to impart to it a definite configuration and this is extremely attractive. There are extremely promising methods for producing optical elements directly in orbit without mechanical processing on the earth, which inevitably lowers the quality of the glass. Visualize that the mirrors of telescopes for exoatmospheric research, whose projects are now being

discussed in different countries of the world, will be fabricated directly in orbit. Fantastic!

"Yes, but real," say the specialists.

"The ancient Romans had a motto -- 'Through the thorns to the stars'," says G. Petrovskiy. "Space technology is now passing through the 'thorns' stage -- difficult, complex, but necessary experiments, without which it is impossible to think about industrial scales of production in orbit, which will serve for us as a stellar 'beacon'."

[501]

#### LEISURE EXPERIMENT ABOARD SPACE STATION

Moscow PRAVDA in Russian 4 Jul 78 p 6

[Article by Yu. Apenchenko: "Will There Be Time for Leisure?"]

[Summary] Everything which occurs in space can be called an experiment. An example is the watching of television. Precisely this is the focus of the "Dosug" (Leisure) experiment. Aboard the ship there are Russian and foreign films which are shown as TV. The on-board TV set, only a little larger than a typewriter, has a screen the size of a cigarette box, but the image is very clear. The Polish TV system prepared several sets of videorecordings and the cosmonauts were asked to say what programs were particularly desired in space...But there is little time for leisure. Polish scientists from the Institute of Aviation Medicine supplied the crew with a miniaturized pulsotachometer which is part of the "Kardiolider" experiment. On the basis of the pulse rate physicians determine man's general state under different conditions and his reaction to different physical loads. The pulsotachometer is designed for monitoring the pulse rate and emitting an appropriate signal to the cosmonaut. For example, a lower limit of 70 beats per minute and an upper limit of 100 beats are set. As soon as the load on the body is reduced, or vice versa, is increased, exceeding the norms, a warning signal is emitted and the cosmonaut must strive to reduce or increase the load. The "Kardiolider" will undoubtedly be useful for people on earth who must carefully check their exertion levels. It will also be useful to athletes.

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#### "SOYUZ-6" COSMONAUT DISCUSSES INDUSTRY IN SPACE

Moscow TRUD in Russian 21 Jul 78 p 3

[Article by G. Shonin: "On the Path to Space Factories"]



[Summary] Industrial production in orbit is one of the most promising and attractive directions in the use of space. This matter has been discussed by USSR Flier-Cosmonaut Georgiy Shonin, a participant in the world's first technological operation in space. He notes that there are still many unsolved problems in space technology. For example, in orbital stations there is never ideal weightlessness. Whereas on earth the acceleration of gravity is equal to unity, in space it varies in a very wide range -- from a hundredth to a millionth of unity. The reasons for these variations are caused by the periodic firing of the stabilizing engines, movements of the cosmonauts within the station, operation of other instruments and systems. Since it is virtually impossible to eliminate these sources of oscillations, in order to ensure the constancy of the course of technological processes it is necessary to create systems compensating these oscillations or it is necessary to select those processes and materials on which these oscillations exert a minimum influence. It is a timely problem to create methods for predicting the course of processes in space on the basis of use of data from ground experiments. This involves a comparative analysis of materials produced under terrestrial conditions at different accelerations created by centrifuges and materials produced in space. Experiments have shown that for some materials, using this method, it is possible to predict how space technology processes will change their properties. In organizing space industry it is necessary to have speedy checking of the quality of the produced materials. The lack of analysis can result in the junking of a whole consignment produced during one prolonged flight. The availability of control instruments for semiconductors and medicines, metals and biological preparations requires that space vehicles carry cosmonaut-operators capable of carrying out research work and making independent evaluations and in complex cases to exchange information with the earth. The work of such an operator will involve preparation of samples for speedy analysis, carrying out analyses and interpreting the collected data. Such specialists must also be able to adjust and repair control and measuring instrumentation.

[509]

#### PSYCHOLOGICAL AND MEDICAL FACTORS CONSIDERED IN SPACE STATION DESIGN

Moscow PRAVDA in Russian 26 Jul 78 p 3

[Article by Yu. Nefedov and S. Zaloguyev: "A Home in Orbit"]

[Summary] There are many problems which cosmonauts must face in day-to-life in space. Steps must be taken to ensure that they will not have the sensation that they are enclosed in a small cabin. And the living conditions for the crew must be as close as possible to life on earth. All this makes it necessary to carry out a series of sanitary-hygienic, physiological and psychological studies. Some of these might seem unimportant on earth. But failure to take them into account could have a considerable negative effect

on the well-being of the crew and its performance. For example, it is very important to select the proper color for the internal surfaces of the station, the degree of its illumination, and arrange things properly. Man's presence in an enclosed cabin is accompanied by the accumulation of some harmful gases. Without a system for air conditioning and purification the cabin would become uninhabitable within a few hours. Therefore, by experimentation it had to be established what the limiting variations of these gases might be for different parameters of microclimate, food intake and different physical loads. The collected data served as the basis for the life support systems for stations and ships. The ship's atmosphere can be contaminated by different kinds of materials, especially polymers and glues which may contain harmful chemicals. The toxicity of all spacecraft construction materials must be ascertained. It is also essential to prevent the occurrence of different types of diseases, for example, those caused by human automicroflora. It is not impossible that in an enclosed space two absolutely healthy persons can contaminate one another, that is, one crew member can develop a disease from microbes hosted by another crew member who himself is unaffected adversely. Under spaceflight conditions the mutual exchange of microorganisms transpires considerably more rapidly than on earth. The mutual exchange of microorganisms is commonplace on earth without harmful consequences. But it is different in space, where unusually unfavorable conditions exist for the multiplication of these microorganisms. These investigations are important not only for space biology and medicine, but also for our medical services on earth. An example is a knowledge of the dependence between the intensity of man's release of chemical substances into his environment and the peculiarities of the metabolic processes transpiring in his body. A knowledge of this dependence opens up prospects for remote diagnosis of various diseases. Studies of the interexchange of microbes in space may help in solving the problem of spreading of diseases from patient to patient in hospitals.

[508]

#### COMMENTS ON SPACEFLIGHT PREPARATIONS

Moscow PRAVDA in Russian 18 Jul 78 p 3

[Article by V. Kravets: "The Crew and the Station"]

[Summary] The preliminary or general stage in the training of cosmonauts includes a study of theoretical disciplines: astronomy, ballistics, flight dynamics, individual applied aspects of mathematics, physics, the fundamentals of operation and design of standard on-board spaceship systems. Then begins exercises in conducting radio communications with the Flight Control Center and search teams. During this period the biomedical training includes increasing body tolerance to accelerations, weightlessness and work in an enclosed space under increased psychological loads. Great attention is being given to the overall physical state of future crews.

The general preparation requires about two years. Crews must be formed. This is accomplished taking into account the individual qualities of the cosmonauts and an analysis of their psychophysiological peculiarities from the point of view of their in-flight compatibility. The program of exercises is identical for the main and stand-by crews. A great part of the time, over 70%, is allocated to skills in the control of on-board ship systems and then the orbital complex as a whole, control of the scientific instrumentation, testing of the experimental systems of the ship and station, carrying out of assembly and disassembly and repair work with standard equipment and scientific instruments, practicing on-board telemetric work and photography with still and motion picture cameras. The crew is taught how to carry out self-examinations in orbit using medical instrumentation. The stage of direct preparations usually occupies 1-1 1/2 years. During this time the crew participates in ground tests of the ship and station systems and in the writing-up of on-board documents. They consult with leading scientists and engineers and become acquainted with the systems on real ships and on stands at enterprises where spaceships are designed and constructed. They carry out flights in complex trainers at the Cosmonaut Training Center. Before a final determination of readiness the crew must take "graduation exams." Each theoretical examination is a two- or three-hour checking of the cosmonaut's knowledge. Involved is a simulated flight in a complex trainer over a period of 8-12 hours with the performance of a great number of operations against a background of artificially induced equipment failures.

[502]

#### COMMENTARY ON DOCKING PROCEDURES OF "PROGRESS-2"

Moscow PRAVDA in Russian 10 Jul 78 p 3

[Article by V. Aleksandrov and V. Syromyatnikov: "There is a Docking!"]

[Text] There have been seven dockings of transport ships with one orbital station in orbit. Such a thing has never happened before in the history of practical cosmonautics. And yet outwardly there have not been very great changes in the "Salyut-6" in comparison with its predecessors. A second docking unit has been added and the design of the station and its systems has been modified. And yet what additional possibilities have appeared! However, this possibly is not very obvious to nonspecialists: the execution of individual operations has become more complex. An example is the docking of a second ship and the functioning of the complex in a docked state.

The advantages of the "Salyut-6" are not limited to the possibility of docking one spaceship instead of two. We recall that the crews Yu. Romanenko and G. Grechko, V. Dzhanibekov and O. Makarov, exchanged transport ships. This made it possible to free the "freight dock" and leave in orbit the "fresher"

"Soyuz-27." This was of more than a little importance considering the record duration of the flight by the station crew.

About a half-hour is allocated to performance of the final operations for ship docking. Usually the process is completed in 12 minutes. During this time more than 20 mechanisms, units and instruments are triggered. First there is shock absorption of the impact between the two multiton vehicles. The head of the docking mechanism shaft enters its receiving nest. A primary mechanical connection, as it is called, is formed. The whole system of shock absorbers extinguishes the energy of motion of the two vehicles relative to one another -- in any direction, in all six degrees of freedom which a body has in space.

At the moment of contact and linkage sensors are triggered, the approach process ends and the docking system is cut in. The small jet engines for the control of ship motion still function from contact to link-up. They seemingly thrust the ship forward, assisting the shaft head to enter into the nest. After link-up the control systems of the ship and station are finally shut down; they have performed their function and are no longer necessary. All subsequent operations for connecting the ship to the station are performed by mechanisms controlled by a special automation system.

Twenty seconds after the link-up there is activation of the drive for tightening the docking mechanism shaft; after all, the rods are at a distance of almost a half-meter apart. In the course of this operation the lever mechanism turns the ship in such a way that the guide pins and the nests of the docking rods fit into one another. When the sensors at their ends come into contact the cosmonauts and the specialists at the Flight Control Center receive a signal: the first and most complex part of the docking has been accomplished.

Then comes the stage of checking the quality of the connection, its tightness. Pressure is imparted and there is a careful check to see whether leakage has occurred. Now it is possible to even out the pressure in the compartments and open the hatches. This moment is awaited with impatience both on the earth and in space, especially when there are crews on either side of the tunnel hatch. This is the culmination of travel over a distance of thousands of kilometers with tens of precise maneuvers and hundreds of complex operations. Space television has made it possible to observe how Yu. Romanenko and G. Grechko, and then V. Kovalenok and A. Ivanchenkov passed the last few minutes prior to the reception of guests: they eagerly wanted this moment to approach and they had the possibility of manually opening the hatch both from within the compartment and from the direction of the tunnel. But in space it is obligatory to have rigorous technological discipline.

The "Soyuz" ship was designed in such a way that all its principal systems can operate in an automatic regime, periodically receiving commands from the on-board control panel or through the command radio link from earth.

At one time doubts were expressed concerning the correctness of choice of this scheme. However, experience has confirmed its rationality. It was possible not only to save the cosmonauts from fatiguing work, but also to carry out unmanned flights with the performance of such complex operations as approach and docking. The dockings of the freighters "Progress-1" and "Progress-2" most clearly manifested the advantages of the strategy for control already selected and checked in the 1960's. These dockings have qualitatively changed the methods used in supplying stations with expendable materials, the possibilities of outfitting it with equipment; the duration of operation has been extended.

At the same time the additional docking unit has complicated many very important operations. It was necessary to refine the peculiarities of docking for all possible combinations from which the complex can consist. It was found that the dynamic characteristics differ appreciably not only for cases of docking to an individual station or to the "Salyut"- "Soyuz" complex, but also during approach to its different units. Thus, four different variants are possible, but if one takes into account some difference in the parameters of the manned transport ship and the freighter, the number of variants increases to eight.

In addition, the relative position of the vehicles and the ratio of their velocities at the time of first contact can vary in a rather broad range. Therefore, in preparations for the "Salyut-6" program it was necessary to "play around" with many tens of different combinations.

After joining to the transport ship the mass of the orbital station increases by almost 1 1/2 times. This means that during docking of the other ship there is an increase in the energy and force of the collision. There is also an increase in the loads on the locks of the docking shaft of the already occupied unit: in comparison with the earlier flying "Salyuts" -- by several times.

It was necessary to solve a difficult problem. It was possible, to be sure, to simply strengthen the system of locks. However, this would require considerable changes in the design of the station, expenditures of time and money. The locks of the docking shaft are very important mechanisms. The space complex literally "hangs" on the hooks of these locks. Their strength governs the safety of the crews. Weighing all the circumstances, it was decided for increasing the carrying capacity of the link-up to make use of the second sets of locks present on the passive docking assemblies of the station.

With the complication of control of this complex, a number of regimes became more forced. The loads on the complex increase even during the walking and running of cosmonauts. In addition, it is necessary to take into account the duration of the forces which arise in order not to allow material fatigue. All this has forced a change in the approach to the designing of the carrying components of the construction, especially "hull" parts.

Docking is the interaction of earthlings with a cosmic base created by their reason and hands. The number of such bases, the complexity and duration of their flights will increase and at the same time there will be an increase in the handling capacity of the "earth-space" passenger and freight transport artery. However much has been done, ahead lies the entire universe, which still must be conquered.

[503]

#### COMMENTARY ON GLASSMAKING IN SPACE

Moscow PRAVDA in Russian 16 Jul 78 p 6

[Article by A. Pokrovskiy: "The 'Fotony' are Flying Over the Earth"]

[Summary] V. Kovalenok and A. Ivanchenkov aboard the "Salyut-6" have melted the first three samples of glass in space. Under terrestrial conditions it is not easy to adhere to all the conditions necessary for the production of perfect glass. Sometimes it is impossible. Gravity is capricious in distributing components in the cooling glass mass. A single bubble in the glass mass can hopelessly ruin a potential optical lens. But computations have shown that under weightlessness conditions it is easier to obtain a uniform mass from substances with different specific gravities. Moreover, in space it is also simpler to achieve the reverse: concentrate additives in necessary places. In addition, on earth great difficulties are caused by the fact that the melt is in contact with the walls of the crucible; in space it is possible to achieve the hardening of glass without crucibles, in a sort of suspended state. On earth the glass must be given the necessary form before use. Mechanical processing distorts the structure of the material surface and subsequent careful polishing cannot completely eliminate the damage. In space it is possible to use such a tool as surface tension of the fluid. Using this scientists are hoping to obtain at once glass in such forms as optical lenses. It is also conceivable, although not in the immediate future, that it will be possible to fabricate optical elements for telescopes of unprecedented size. V. Kovalenok and A. Ivanchenkov are simultaneously carrying out two operations -- preparing to supplement the fuel supplies and unload the "Progress-2." However, this time, in contrast to the first space tanker, the refueling is entirely in the hands of an automated system. The experience of Yu. Romanenko and G. Grechko indicated that the cosmonauts cannot keep this operation under their constant control. Instead, now they check the operation of the automatic system from time to time. Special space hours have now been set free for carrying out other work.

[500]

## COMMENTS ON SOVIET SPACE WALK

Moscow PRAVDA in Russian 30 Jul 78 p 3

[Article by Yu. Apenchenko: "'Fotony' Over the Earth"]

[Summary] Vladimir Kovalenok and Aleksandr Ivanchenkov have opened the door into open space. This operation began early on Saturday morning. At the Control Center no one could view the first steps which the two cosmonauts took outside the station. In accordance with the program, the TV cameras were turned on during the next revolution. But even without the cameras the specialists at the Control Center can clearly monitor every motion of the cosmonauts. All operations have been repeatedly, to the smallest detail, practiced on earth in a special hydrobasin, put on motion picture film, and repeatedly viewed and analyzed... The space walk has just begun, but preparations for it began ten days ago... For example, on Thursday there was practice of the first stage in the operation -- up to the opening of the hatch. There are good reasons for emerging into space. For example, it might be necessary to remove the cover of a telescope which had accidentally been left on, it might be necessary to inspect or repair instruments or components on the outside of the ship, such as solar cells... In this case the cosmonauts wanted to reach three packings on the outside of the station, made of rubber, plastics, etc. These have been in open space for more than 10 months and have been exposed to considerable temperature drops, vacuum and radiations. Specialists want to find out how these materials have stood up. Then the cosmonauts took samples of paint, metal and glass. Then they moved on to the instrument used in investigating the impact of micrometeorites. After 4,785 revolutions around the earth, specialists wanted the cosmonauts to recover the panel for its return to the earth for study. The cosmonauts were outside the ship for a full 1 1/2 revolutions around the earth -- 2 hours.

[517]

## WORK OPERATIONS AT FLIGHT CONTROL CENTER DESCRIBED

Moscow PRAVDA in Russian 25 Jun 78 p 6

[Article by V. Gubarev: "Report from the Flight Control Center: Communications Session"]

[Summary] USSR Flier-Cosmonaut V. Rozhdestvenskiy stresses the importance of work at the Flight Control Center in the professional training of a cosmonaut. He states that this is necessary for all those who are making ready for a future launching. And all the operators dream of their own flight into space. The operators in the course of their work become intimately familiar with everything which is transpiring aboard the ship. The chief operator post is one of the links in the cosmonaut profession. This is a necessary

stage in the road into space; indeed, it is mandatory. Many of the chief operators have become ship pilots. Requests and questions are transmitted down to the earth from space and immediately this will be "fielded" by one of the specialists present in the control room who is responsible for a particular system or experiment. The specialists supply their information to the chief operator, and only he communicates with the cosmonauts. The voices of the cosmonauts are not heard in the hall, only through earphones. The chief operator is the "crew on earth."

[471]

#### ADDITIONAL NOTES FROM FLIGHT CONTROL CENTER

Moscow PRAVDA in Russian 2 Jul 78 p 2

[Article by A. Pokrovskiy: "Space Time"]

[Summary] Every day the newspapermen at the Flight Control Center are given the schedules for the main and visiting crews. The work includes implementation of the "Sirena" experiment, which was prepared at the Physics Institute of the Polish Academy of Sciences. The objective of the experiment is the testing of technological procedures for producing semiconductor materials in a state of weightlessness. The cosmonauts placed two ampules in the "Splav-01" furnace. One contained a compound of cadmium, mercury and tellurium, which sharply differ from one another in specific gravity. They had to be melted and then subjected to regulated cooling. According to calculations, weightlessness will afford a possibility for obtaining a more homogeneous substance than is possible under terrestrial conditions. In the other ampule, in a gas medium consisting of cadmium, mercury and selenium, it is necessary to grow a semiconductor crystal. In this experiment the obligations of the cosmonauts are not limited to placing the ampules in the furnace and checking the cooling process. It is important to shut down all engines of the orientation system in order to reduce to a minimum any residual acceleration, that is, the influence of microgravitation must be eliminated. Even physical exercises are forbidden at this time. For cosmonauts even eating at times becomes an experiment. For example, it has been noted that taste sensations change in space. Determination of the threshold of taste sensations was therefore the objective of an experiment formulated by specialists at the Polish Institute of Aviation Medicine. A special instrument, the electrogustometer, was created for this purpose. By means of a weak electric current it is possible to determine the moment of appearance of taste sensations.... The cosmonauts spend every free moment at the windows marveling at the sight of their native earth. Hermaszewski sends to earth a message for the other non-Soviet cosmonaut candidates from Bulgaria, Hungary, East Germany, Cuba, Mongolia and Romania telling them what great experiences await them...

[472]



## Abstracts of Scientific Articles

### IONOSPHERIC EFFECTS OF MAGNETOSPHERIC SUBSTORMS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 263-266

[Article by G. N. Pushkova and L. A. Yudovich, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Ionospheric Effects of Magnetospheric Substorms at Nighttime"]

[Abstract] The paper gives an analysis of the ionospheric effects of 25 isolated magnetospheric substorms on the basis of data from the middle latitude station Moscow for July, September, November and December 1965. The method of superposing of epochs was used in constructing synthetic substorms for different sectors local time. It is concluded that in the phase of generation of substorms in the entire time interval from the evening to the morning hours in the middle latitudes there are no systematic changes  $\Delta h_p$  with a value  $\Delta h_p \geq 10$  km. This is evidence of absence of any additional zonal electric field at the altitudes of the ionosphere with an intensity 2 mV/m. In the evening (1800-2100 LT) and nighttime (2100-2400 LT) sectors in the period of substorm development  $\Delta h_p > 0$ . This means that the zonal component of the electric field is directed to the east, which does not agree with measurements made earlier at  $L = 5.4$ . In the morning sector the appearance of  $\Delta h_p > 0$  in the phase of substorm development assumes the existence of a field  $E_y$  directed to the east. In the evening sector there are substorms with a zonal electric field of westerly direction. The electric field in the solar wind during the period of individual substorms has an azimuthal component  $E_y \sim 1-2$  mV/m. The direction of the vertical drift of ionization in the F field is not directly related to the direction of this field. Evidently, in the middle latitudes the electric field in the period of some substorms is caused to a considerable degree by fields of ionospheric origin.

[484]

#### NAVIGATION-CONTROL ALGORITHM FOR DESCENT OF SPACECRAFT IN MARTIAN ATMOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 16, No 3, 1978 pp 370-377

[Article by O. A. Nogov, "Navigation and Control Algorithm for Descent of Spacecraft in the Segment of Aerodynamic Braking in the Martian Atmosphere"]

[Abstract] Information on the formulation of algorithms for control of the descent of spacecraft in the segment of aerodynamic braking in the Martian atmosphere has been published by N. M. Ivanov and A. I. Martynov, KOSMICH. ISSLED., 10, No 2, 185, 1972; 11, No 5, 643, 1973. In the first of these studies the algorithm was formulated on the assumption that the spacecraft carries only simple measuring and computing devices. The results have indicated that for this algorithm the maximum deviations in the final velocity relative to optimum control are extremely great, attaining 120 m/sec. In the second of the cited articles a control algorithm is proposed in which an electronic computer was used. Using the digital computer there is numerical integration of the spacecraft equations of motion and on this basis there is periodic variation of the effective aerodynamic quality  $K_{eff}$  for satisfying the requirement of ensuring a stipulated final velocity at some specified altitude. The approaches such as described in these two papers are encumbered by a number of inadequacies which the author has succeeded in eliminating.

[469]

#### SPECTRUM OF ALPHA PARTICLES IN INNER RADIATION BELT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 16, No 3, 1978 pp 459-461

[Article by V. N. Lutsenko and N. S. Nikolayeva, "Relative Content and Spectrum of Alpha Particles in the Earth's Inner Radiation Belt According to Measurements on the 'Prognoz-5' Artificial Earth Satellite"]

[Abstract] This paper gives the preliminary results of measurements of the spectra of  $\alpha$ -particles and protons with energies 7-28 MeV/nucleon in the inner belt ( $1.6 \leq L \leq 2.1$ ) carried out on the "Prognoz-5" satellite in December 1976. The measurements were made with an I-1 energy, charge and mass spectrometer. Particles were identified by the simultaneous measurement of energy losses  $\Delta E$  in the first silicon detector with a thickness of  $400 \mu m$  and a residual energy  $E$  in two parallel detectors, each with a thickness of 2 mm. The amplitudes of the  $\Delta E$  and  $E$  pulses were measured using 256-channel amplitude-digital converters. Each 10 sec measurements were made of  $\Delta E$  and  $E$  for one particle. For increasing the quantity of information on  $\alpha$ -particles use was made of a priority system allowing measurement of the amplitudes of pulses from a proton only in a case when not one  $\alpha$ -particle was registered in 10 sec. The amplitude analysis system was supplemented by a

system for counting the total number of protons and  $\alpha$ -particles entering the telescope. Measurements in the inner radiation belt were possible due to the capacity of the instrumentation to operate at great loads (up to  $10^5 \text{ sec}^{-1}$ ). During motion in orbit the satellite twice intersected the radiation belt on each revolution. Two maxima in the counting rate correspond to two intersections of the inner belt and the minimum between them corresponds to the segment of the orbit beneath the belt. Figures 1 and 2 in the text show the results of these measurements; these data are interpreted.

[469]

#### SATELLITE STUDY OF ELECTRONS WITH ENERGIES 0.3-3 MeV

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 203-205

[Article by Yu. V. Mineyev, I. A. Savenko, V. G. Savel'yev and Ye. S. Spir'kova, Nuclear Physics Institute, Moscow State University, "Study of Electrons With Energies 0.3-3 MeV on the 'Prognoz-4' Satellite"]

[Abstract] The article gives a brief description of an improved differential electron spectrometer making it possible to register fluxes of electrons with energies 0.3-3 MeV on the "Prognoz-4" satellite. The spectrometer was modified in such a way as to facilitate study of electron variations in interplanetary space. The telescope consisted of three semiconductor detectors surrounded by a shielding of a plastic scintillator, scanned by a photomultiplier. The telescope was in an aluminum collimator with an aperture angle  $60^\circ$ . The anticoincidence shielding makes it possible to decrease the background from penetrating cosmic radiation and from protons with flight beyond the angle of electron registry. Figure 2 in the text is a block diagram of the spectrometer. The figure is used in a detailed discussion of instrument structure and functioning. An example of variation in the intensity of electrons in five energy intervals from 0.3 to 3.0 MeV is given; these particular data were registered by the spectrometer upon entry into the earth's magnetosphere from interplanetary space and on emergence from it. An interpretation of these data is given.

[484]

#### IRREGULAR IONOSPHERIC STRUCTURE IN FIELD OF OBLIQUELY INCIDENT RADIO WAVE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 214-217

[Article by V. I. Novozhilov and S. M. Savel'yev, "Irregular Structure of the Ionosphere in the Field of a Strong Radio Wave With Slant Incidence"]

[Abstract] When the ionosphere is acted upon by powerful radio waves there can be a substantial change in its irregular structure. This causes a change in the statistical properties of the probing waves propagating through the affected region. This paper examines the results of an experimental study of variations of the parameters of ionospheric inhomogeneities during slant incidence of powerful radio waves on the ionosphere. Data were obtained in April 1975 by registry of signals registered at spatially separated points. The probing signals used were slant sounding signals created by a transmitter located about 3,000 km from the observation point. The data presented here from the spaced reception of these slant sounding signals made it possible to obtain some data on the dynamics of the irregular structure of the ionosphere caused by powerful radio waves. The data indicate a decrease in the effective size of the inhomogeneities and an increase in fluctuations of the electron concentration in the effective range of the disturbing field.

[484]

#### STUDY OF CHARACTERISTICS OF SW SIGNALS ALONG PATH WITH SLANT SOUNDING

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 275-280

[Article by D. V. Blagoveshchenskiy and N. F. Blagoveshchenskaya, Siberian Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Investigation of the Characteristics of SW Signals Jointly With Data from Slant Sounding of the Ionosphere"]

[Abstract] The purpose of this study was an investigation of the propagation of short-wave radio waves along a path outfitted with a slant sounding system. In contrast to earlier experiments, this experiment had a complex character: slant sounding apparatus was used in finding the characteristics of the propagating radio waves and at the same time the statistical parameters of signals reflected from the ionosphere were determined. Then all the parameters were compared for ascertaining the physical essence of the phenomena and discovery of the possible patterns and interrelationships. The path on which the measurements were made is classified as subauroral. The path length is 2,800 km, that is, it is optimum from the point of view of the quality of the communication channel. The transmission point is located in the middle latitudes and the reception point is in the zone of auroral activity. The direction of the path was northeasterly relative to the transmission point. The region of reflection of radio waves from the ionosphere falls in the immediate neighborhood of the auroral zone. Such radio paths are interesting in that the influence of auroral activity makes it possible to investigate a broader range of states of the propagation channel than in the middle latitudes. It is demonstrated that on the basis of the determined stable dependence of signal parameters on radio wave propagation conditions it is possible to choose the optimum radio communication regime.

[484]

## OBSERVATIONS OF LOW-LOW SATELLITE PAIR FOR GEOID DETERMINATIONS

Warsaw GEODEZJA I KARTOGRAFIA in Polish Vol 27, No 1, 1978 pp 17-27

[Article by Jan Krynski, "Application of Low-Low Satellite Pair Observations to Geoid Determinations"]

[Abstract] The paper presents the results of a study of local geoid determinations with use of low-low satellite pair observations, especially when ground-based observations are scarce. The collocation method is applied because it improves determinations of the local geoid, permits consistent integration of heterogeneous data and increases accuracy. An analysis indicated that it is sufficient to use a limited number of satellite observations in an area of  $7^\circ \times 7^\circ$  with satellite altitude  $h = 300$  km. It is also sufficient that distances between observation profiles be of the order of  $3^\circ$ . The coverage of the entire earth with such a dense set of observations would require four days in the case of a polar satellite orbit. Changes in distances between satellites of 200 to 300 km have no essential effect on the accuracy of the results. For each reference field of a definite degree and order there is an optimum altitude at which observations should be made. For a reference field (18, 18) and satellite altitude  $h = 300$  km one may expect an accuracy of  $\pm 2$  meters. The analysis of measuring errors shows that only observations of a satellite pair better than  $\pm 0.5$  mm/sec can produce an improvement in the geoid determination. A combination of low-low satellite pair observations with ground-based measurements can improve the accuracy of geoid determinations up to 25%.

[381]

## WIND BEHAVIOR IN POLAR THERMOSPHERE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 286-293

[Article by L. A. Andreyeva, L. A. Katesev and T. I. Shchuka, Institute of Experimental Meteorology and Arctic and Antarctic Scientific Research Institute, "Peculiarities of Wind Behavior in the Polar Thermosphere Under Quiet and Disturbed Conditions"]

[Abstract] The paper presents the results of wind velocity measurements carried out at Kheys Island in 1968-1974 using artificial luminescent clouds. The authors discuss the possible factors exerting an influence on wind behavior for different positions of the observation point relative to the auroral oval. Thus, at the near-midnight hours, when Kheys Island is situated in the polar cap, the most important influence on wind velocity can evidently be exerted by ion convection, acting constantly in one direction. The influence of a thermal source in this case is not obvious. At evening twilight, when Kheys Island is situated close to the boundary between the polar cap and the oval, a considerable influence is exerted on the wind by a heat

source situated to the southeast of the observation point. This conclusion confirms the opinion expressed earlier that there is a considerable influence of a heat source on the wind in the polar region and that such a source is situated in the region of the westerly electrojet (more powerful than the easterly electrojet). It is concluded that more definite results concerning the factors exerting an influence on the wind over Kheys Island can be obtained with the simultaneous launching of neutral and ionized clouds, and also with simultaneous measurement of temperature in the polar cap and auroral oval regions.

[484]

#### EXCITATION OF ARTIFICIAL AURORA

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 294-299

[Article by M. V. Samokhin, Radioengineering Institute USSR Academy of Sciences, "Possibility of Excitation of Artificial Aurora in a Region Longitudinally Remote from the Point of Electron Beam Injection"]

[Abstract] A study was made of injection of an electron beam with an energy  $\sim 10$  keV in the neighborhood of the point of self-intersection of the mean drift trajectory in a dipole magnetic field and an electric convection field. The author has computed the intensity of the electron flux at an altitude of 100 km in dependence on latitude and local time. It was found that with a decrease in the geocentric distance to the drift shell the mirror points of the electrons drop down under the influence of the electric convection field. As a result, by means of injection near a special point on the closed mean drift trajectory the electron beam can create an artificial aurora on the lines of force corresponding to the lower latitudes and a later local time relative to the corresponding coordinates of the injection point. Computations show that with an electron energy  $\sim 10$  keV and a beam current exceeding 10 A it is possible to create a visually observable aurora on lines of force displaced by 2-3 hours local time.

[484]

#### ELECTRON TEMPERATURE IN IONOSPHERIC TROUGH

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 3, 1978 pp 432-435

[Article by V. V. Afonin, O. P. Kolomiytsev and Yu. G. Mizun, Space Research Institute, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation and Polar Geophysical Institute, "Measurement of Electron Temperature on Satellites and Peculiarities of its Behavior in the Region of The Main Ionospheric Trough"]

[Abstract] The article examines the dynamics of the  $n_e$  trough and the maximum in the latitudinal variation of  $T_e$  as a function of geomagnetic activity. On the basis of ground observations and satellite measurements of temperature on a high-frequency probe aboard the "Kosmos-378" satellite the authors analyze the behavior of the ionosphere during the period 10-20 December 1970. During this period there was one isolated substorm with high activity. The ground measurements used were data from vertical sounding of the ionosphere at 11 observatories. It was found that in the main phase of a substorm there is a marked displacement of the  $T_e$  maximum and the  $n_e$  trough over a period of several hours in the direction of the equator and then their monotonic return to the initial position over the course of several days. In the considered specific case  $D_{st} \approx 140\gamma$  in the main phase of an isolated substorm the  $n_e$  trough is situated at  $L \leq 2$ . The dependence of  $T_e$  on latitude varies in different substorm stages. Near the substorm maximum and at the end of the restoration phase the latitudinal extent of the  $T_e$  increase is  $\Delta L \sim 1$ , and during the main part of the restoration phase  $\Delta L$  is several units. There is also a "broadening" -- a second small maximum  $T_e$  at  $L \approx 2, 3$  is also observed in the latitudinal variation. It is clear that using data from synchronous ground and satellite measurements of  $T_e$  and  $n_e$ , with  $D_{st}$  variations taken into account, it is possible to predict the dynamics of the  $n_e$  trough in space and time.

[463]

#### MAGNETOSPHERIC PROPAGATION OF SW SIGNALS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 3, 1978 pp 440-447

[Article by G. V. Bukin, Institute of Terrestrial Magnetism and Radio Wave Propagation, "Experimental Investigations of the Magnetospheric Propagation of Short-Wave Signals Along an Earth-Earth Path"]

[Abstract] On the basis of data registered in the territory of the Soviet Union and on the ships of the Space Research Service operating in magnetically conjugate regions the authors examine experimental data on the magnetospheric propagation of short-wave signals during periods of high and low solar activity. The study revealed that a magnetospheric signal is observed in the morning and evening hours. This is evidently associated with periods of existence of pumping of photoelectrons from one hemisphere to another. There is a definite correlation between the magnetospheric signal and the  $K_p$  index. It decreases to  $K_p \approx 3$  and then begins to increase. Such variations in  $t_{sw}$  are attributable to the shortening and lengthening of lines of force in different phases of geomagnetic disturbances. During a period of the solar activity maximum the magnetospheric signals are observed more frequently and at greater working frequencies than during the period of the minimum, which is evidently associated with a decrease in the electron concentration in the

plasmosphere in a period of low solar activity. A magnetospheric signal is usually observed with double magnetospheric splitting. In the case of measurements with a radio telescope in two cases two signals were detected simultaneously: one was at an angle  $46-50^\circ$  and the other was at an angle of  $54-60^\circ$ .

[463]

#### IONOSPHERIC GENERATION OF VLF RADIATION

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 3, 1978 pp 466-472

[Article by M. S. Kovner, V. A. Kuznetsova and Ya. I. Likhter, Gor'kiy State University, Institute of Nuclear Physics Moscow State University, and Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Ionospheric Generation of VLF Radiation"]

[Abstract] In this study, on the basis of experimental data on the spatial distribution of low-frequency electromagnetic radiation in the VLF range, collected on board the "Interkosmos-5" artificial earth satellite, it is postulated that a considerable part of middle-latitude VLF radiation is generated at altitudes 300-400 km. Measurements aboard this satellite were made during the period December 1971 through April 1972 at altitudes 200-1,200 km. The regularities observed in these observations indicate that the observed VLF radiation is generated by high-energy particles of the radiation belts at the altitudes of the maximum of the F2 layer (300-400 km). The generation of the waves is associated with anisotropy of the particle pitch-angle distribution. The distribution function is most anisotropic at low altitudes. At altitudes  $h \approx 300-400$  km, where the maximum level of VLF radiation is observed, the concentration of cold plasma  $N_e$  during the daytime is 1.5-2 orders of magnitude greater than at nighttime. Although the degree of anisotropy of the pitch-angle distribution function for high-energy particles does not change from day to night, the conditions for generation will be different: during daytime the refractive index will be greater, and accordingly, the phase velocities of the waves will be less and for a large number of particles there will be satisfaction of the kinematic conditions for Cerenkov and cyclotron radiation. Equations are derived for estimating radiation intensity.

[463]

#### INTERRELATIONSHIP OF MAGNETOSPHERIC CONVECTION AND POLAR IONOSPHERE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 3, 1978 pp 480-486

[Article by N. K. Osipov and A. M. Mozhayev, Krasnoyarsk State University and Rostov-on-Don Civil Engineering Institute, "Dynamics and Interrelationship of Magnetospheric Convection Structures and the Polar Ionosphere"]



[Abstract] The authors examine the possibility of numerical modeling of three-dimensional transfer processes in the polar ionosphere and the consequences. Also examined is the interrelationship between changes in the structure of magnetospheric convection and variations in structure of the polar ionosphere caused by convective transfer. A model of magnetospheric convection is presented, followed by a description of three-dimensional modeling of the polar ionosphere, and then a discussion of the dynamics of structure of the polar ionosphere. The modeling data indicate that the principal factor determining the dynamics of structure of the F2 region of the ionosphere is the global circulation of magnetospheric-ionospheric plasma.

[463]

#### SPECIAL METHOD FOR ORBITAL DETERMINATIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 16, No 3, 1978 pp 331-338

[Article by Ye. O. Kotov, "One Method for Determining and Orbit from Observational Data"]

[Abstract] The author proposes a simple method for determining an orbit in observation intervals small in comparison with the period of revolution. The paper gives the results of investigations of the characteristics of the method used in mathematical modeling on an electronic computer. A great number of computations were made in which the following were varied: 1) orbital eccentricities and altitudes (to the altitudes of stationary satellites); 2) number of individual measurements; 3) mean square measurement errors and also the relationship between the mean square errors along the line of sight and the errors in the plane perpendicular to the line of sight; 4) realizations of random measurement errors; 5) relative position of the observation point and the observed orbital segments. The modeling measurement errors contained two components, one of which was correlated in time and the other uncorrelated. The problem of determining the orbit was examined when the ratio of the observation interval  $\Delta t$  to the period of satellite revolution  $T$  satisfied the condition

$$\sqrt{\Delta t/T} < 0.25.$$

A comparison was made of evaluations of orbital parameters obtained by the proposed method and evaluations obtained by the precise minimization method without use of approximate approximations of motion. The difference in evaluations of orbital parameters in the most extreme cases was an order of magnitude less than the errors in determining these parameters.

[469]

## SATELLITE METHOD FOR STUDYING EARTH'S GRAVITY FIELD

Warsaw GEODEZJA I KARTOGRAFIA in Polish Vol 26, No 4, 1977 pp 241-253

[Article by Jan Krynski, "Investigation of the Earth's Gravity Field by Using Observations of a Low-Low Satellite Pair and the Collocation Method"]

[Abstract] Comfort proposed the direct mapping of gravity anomalies by using Doppler tracking between a satellite pair. Balmino was the first to discuss the accuracy of measurements by this method as a function of satellite altitude. In this paper attention is centered on the influence exerted on the satellite pair by gravity. Proceeding from the geometry of the satellite-satellite system and using the differential equations of satellite motion a physical interpretation is presented of changes in the relative velocity of the satellite pair. Observation equations are derived and their form is discussed relative to numerical applications. A general outline is given of the use of the collocation method for an analysis of the method and for its practical application. Observations of the low-low satellite pair furnish valuable information on the earth's gravity field. They may be used in particular in geodynamic investigations of a local nature as in local variations of the earth's gravitational potential.  
[179]

## DOPPLER METHOD FOR INVESTIGATING THE EARTH'S GRAVITY FIELD

Warsaw GEODEZJA I KARTOGRAFIA in Polish Vol 26, No 4, 1977 pp 235-239

[Article by Janusz B. Zielinski, Department of Planetary Geodesy, Space Research Center, PAN, "Investigation of the Earth's Gravity Field Using Differential Doppler Measurements"]

[Abstract] The article discusses the satellite-to-satellite tracking technique which was first proposed by Wolff in 1969 and which involves using two satellites in the same circular orbit at a distance of about 200 km from one another. The Soyuz-Apollo experiment in 1975 confirmed in principle the potentialities of this method. The paper proposes and considers in detail another concept of the satellite-to-satellite tracking technique in a version of a low-low satellite pair, as follows. The subsatellites (SS) are launched from a mother satellite (MS). The initial impulses are so well matched that the SS are moving in the same plane as their MS, and their distance from one another remains more or less constant, whereas their distance from the MS slowly but steadily increases. The difference in velocity between the MS and each of the SS is measured by using Doppler effect techniques. From differences in the measurements one can obtain the relative velocity of the SS in relation to one another. The paper presents a measurement scheme and concludes that to determine the geoid with an accuracy of  $\pm 1$  m it is necessary to measure the relative velocity in space with an accuracy of 0.05 mm/sec. The method for solving this problem is given.  
[179]

## EFFECT OF LARGE-SCALE INHOMOGENEITIES ON WAVEGUIDE RADIO WAVE PROPAGATION

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 18, No 2, 1978 pp 267-274

[Article by N. D. Borisov, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Influence of Large-Scale Inhomogeneities on Waveguide Propagation of Short Radio Waves"]

[Abstract] Short radio waves are capable of propagating great distances in ionospheric wave channels. In addition to adiabatic changes in the properties of waveguides, there are also nonadiabatic changes associated with the presence of inhomogeneities of different scales in the ionosphere. In this paper use is made of the parabolic equation method for describing the scattering of radio waves on large-scale inhomogeneities in ionospheric channels. The author has approximately determined the waveguide modes under conditions when nonadiabatic inhomogeneities are present. This makes it possible to analyze scattering effects with the discreteness of the wave number spectrum taken into account. It was clarified that the discreteness of the wave spectrum exerts a considerable effect only when the wavelength of the inhomogeneity approaches the period of ray oscillation.

[484]

## INVESTIGATION OF LIGHT REFRACTION IN ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 14, No 5, 1978 pp 467-473

[Article by A. S. Gurvich, V. N. Kubasov, A. A. Leonov, A. I. Simonov and T. N. Kharitonova, Institute of Physics of the Atmosphere, "Investigation of Light Refraction in the Atmosphere in the 'Apollo-Soyuz' Program"]

[Abstract] In July 1975, in accordance with the "Apollo"- "Soyuz" program, the cosmonauts aboard the "Soyuz-19" spaceship obtained a series of photographs of the sun during its rising above the earth's horizon. The purpose of the experiment was clarification of the possibility of measuring light refraction on the basis of the degree of deformation of the solar disk image. The object of observation was the sun, since the difference in refractions causing disk deformation is easier to measure than refraction itself. The degree of deformation (flattening) is dependent on solar angle above the horizon, and for a particular solar altitude it is dependent on the profile of the refractive index on the line of sight. Therefore, on the basis of the degree of deformation it is possible to judge the state of the atmosphere. In observations of the sun from space the flattening effect is increased in comparison with observations from the earth's surface. Accordingly, in this article, for different models of the atmosphere, the authors give theoretical computations of deformation of the solar disk

which should appear during observations of the sun near the horizon. This is followed by experimental deformation values obtained from photographs obtained from space. The satisfactory agreement between the computed and observed values show that on the basis of flattening of the solar or lunar disk it is possible with a high accuracy to accomplish a tie-in of photographs to altitude above the horizon with allowance for atmospheric refraction. With an increase in the accuracy of refraction measurements it will be possible to obtain information on the distribution of density in the atmosphere.

[434]

#### STUDY OF EARTH'S ATMOSPHERE USING OUTGOING SUBMILLIMETER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 14, No 5, 1978 pp 553-557

[Article by S. V. Solomonov and A. S. Khaykin, Physics Institute USSR Academy of Sciences, "Possibility of Investigation of the Earth's Atmosphere Using Outgoing Submillimeter Radiation in Relatively Broad Spectral Bands"]

[Abstract] Using an electronic computer the authors carried out computations of the weighting functions characterizing the contribution of individual layers of the atmosphere to outgoing radiation and also the intensity of radiation and brightness temperatures in relatively broad reception bands. A study was made of 235 spectral lines. In the computations it is assumed that atmospheric layers up to an altitude of 80 km radiate. The results of computations of brightness temperature and weighting functions in relatively broad parts of the submillimeter spectrum revealed that in this case the principal contribution is from radiation in the wings of the water vapor absorption lines, that is, the resultant effects in a broad band in the case of radiation transfer in the atmosphere are caused for the most part by absorption in the transparency windows (near the absorption minima). In an experiment on "Kosmos-669," carried out in the range  $15\text{--}25\text{ cm}^{-1}$  and  $70\text{--}125\text{ cm}^{-1}$ , it was confirmed that in the global distribution of brightness obtained in the experiment there were large-scale variations characterized by a relative decrease in brightness of submillimeter radiation in the tropical region and its decrease in the temperate latitudes. It is shown that observations of outgoing submillimeter radiation by a satellite in relatively broad spectral bands make it possible to exclude the influence of the underlying surface and investigate the radiation of substantially different layers of the cloudless atmosphere. The registered radiation has information on the moisture content of the investigated layers and this affords a possibility for formulating the inverse problem: reconstructing the profile of moisture content in the atmosphere from measurements of outgoing radiation in relatively broad reception bands.

[434]

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ACOUSTIC-GRAVITATIONAL RESONANCE IN ATMOSPHERE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 240, No 6, 1978 pp 1328-1331

[Article by L. M. Alekseyeva and A. V. Getling, Scientific Research Institute of Nuclear Physics, Moscow State University, "Acoustic-Gravitational Resonance in Atmosphere Under Auroral Ionosphere With Allowance for Dissipation"]

[Abstract] During periods of an increase in the electric field (usually during increased auroral activity) pressure fluctuations occur at ionospheric altitudes. They must cause standing acoustic-gravitational waves in the lower-lying atmosphere. A discrete series of frequencies and the vertical distribution of the amplitude of atmospheric disturbances under these conditions were investigated in an earlier study by the author (L. M. Alekseyeva, GEOMAGNETIZM I AERONOMIYA, Vol 17, No 4, 756, 1977) in the approximation of an isothermicity of the undisturbed atmosphere and an adiabaticity of oscillations. In this paper, a continuation of her earlier work, the author, in collaboration with A. V. Getling, investigates forced oscillations of the atmosphere having finite viscosity and thermal conductivity. It was found that in some intervals of altitudes atmospheric disturbance during resonance exceeds ionospheric disturbance a thousandfold. At the earth's surface in the case of a summer profile the disturbance profiles for the three considered resonance frequencies were 5, 7.5 and 9.6 times respectively greater than ionospheric disturbance. The  $\Pi(z)$  values [vertical change in disturbance] here were obtained for a regime of steady oscillations. Probably during periods of magnetic disturbance pressure fluctuations in the ionosphere are unable to pump the atmosphere to such amplitudes and the influence of the ionosphere on the atmosphere is not manifested so clearly as might be expected.  
[483]

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